NOV 1 6 1944

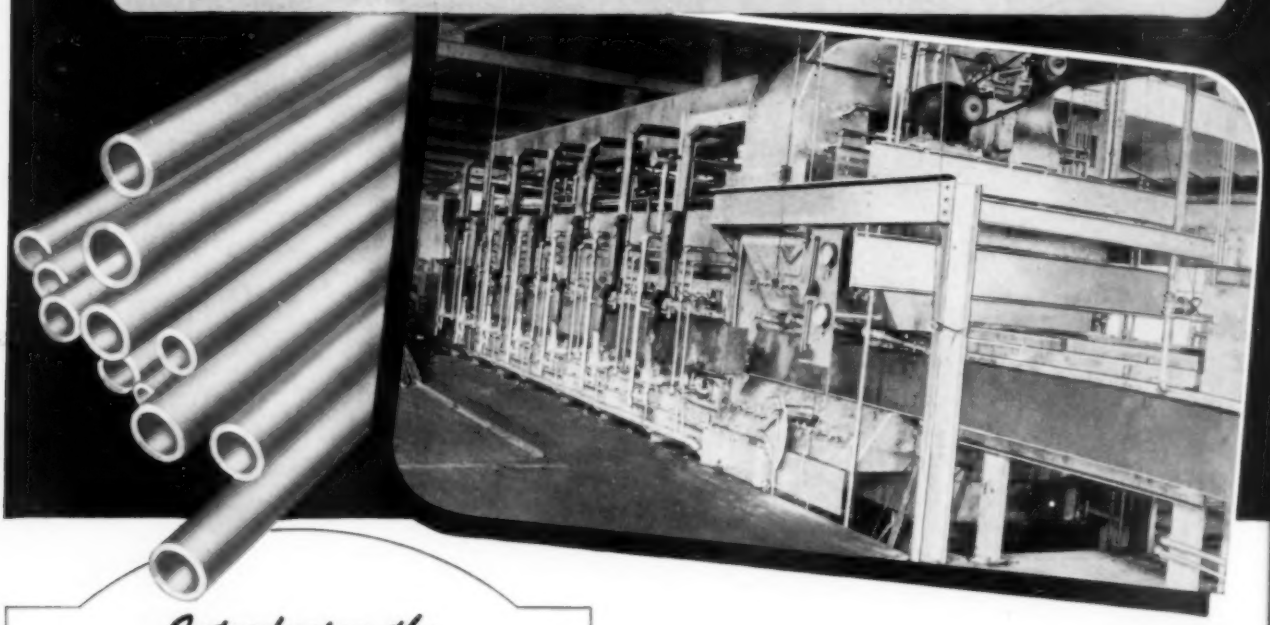
# METAL PROGRESS

1 9 NOVEMBER 4 4

# Bright Normalizing and Annealing of Tubing

*and the development of the*

# SUPER-FAST GAS QUENCH



*Introducing the*

## SUPER-FAST GAS QUENCH

Surface's background and knowledge of controlled atmospheres and convection cooling made possible the development of the super-fast gas quench for welded aircraft tubing X-4130. Of most importance, this development made possible the use of welded aircraft tubing which heretofore had limited use in aircraft construction.

Bright normalizing and annealing together with the super-fast gas quench will find other applications of equal importance to postwar production. Consult Surface Engineers on problems that you may have.

● Every foot of aircraft tubing is inspected immediately after the final anneal or normalizing heat treatment. This would be impossible if scale or oxide were present on the surface of the tube. Therefore it must be bright normalized or annealed.

The first Surface Combustion Bright Normalizing and Annealing unit was installed in 1934 and since that time there have been more than 30 units placed in operation in tubing plants. These are of the radiant tube, roller hearth type utilizing DX prepared atmospheres to prevent scale or oxide on the metal surface. The importance of this development to the war effort is indicated by the fact that 24 of the total units installed were made since 1940.

*The Heat Treater's Helping Hand*

**'Surface'**

SURFACE COMBUSTION • TOLEDO 1, OHIO

**Standard and Special Industrial Furnace Equipment for:** Forging, Normalizing, Annealing, Hardening, Drawing, Carburizing, Nitriding and Heating. Special Atmosphere Generators. *Write for bulletins.*

# Metal Progress

November 1944, Vol. 46, No. 5

## *Table of Contents*

Metal Progress is indebted to Rustless Iron and Steel Corp. of Baltimore for the loan of the four-color engraving used on the front cover representing the electric furnace melt shop.


Post-War Steel and Its Treatment .. .. .. .. .. 1067
by Harry W. McQuaid

Robert Crooks Stanley .. .. .. .. .. .. .. .. .. 1074
Biographical Appreciation of 1942 Recipient, Medal for the Advancement of Research

Methods for Computing Springback When Bending Stainless Steel .. .. .. .. .. .. .. .. .. 1077
by C. M. Brown, W. O. Binder, and Russell Franks

National Metal Congress, 1944 (a Non-Technical Report) 1081
by Edward C. McDowell, Jr.

Acid Electric Furnaces and Steel (Foundry Problems) 1086
Report of the second Electric Furnace Steel Conference, A.I.M.E.

Furnaces for Salt Baths .. .. .. .. .. .. .. 1089
by Leon D. Slade

Notes on Synthetic Rubber and the Necessary Equipment 1091
by Myron Weiss

Transformation of X-4130 Steel During Continuous Cooling .. .. .. .. .. .. .. .. .. 1096-B
Data Sheet by C. A. Liedholm, S. E. Lopez and W. C. Coons

Diagram of Transformation During Continuous Cooling of Steel (a Necessary Guide for Propeller Heat Treatment) .. .. .. .. .. .. .. .. .. 1097
by C. A. Liedholm

Notes About Some Good Books .. .. .. .. .. .. 1102
Materials and Processes, edited by J. F. Young
A Summer's Reading
Physics of Metals, by Frederick Seitz

Personal Items .. .. .. .. .. .. .. 1108, 1110, 1112

Manufacturers' Literature .. .. .. .. .. .. 1120, e.s.

Index to Advertisers .. .. .. .. .. .. .. .. 1174

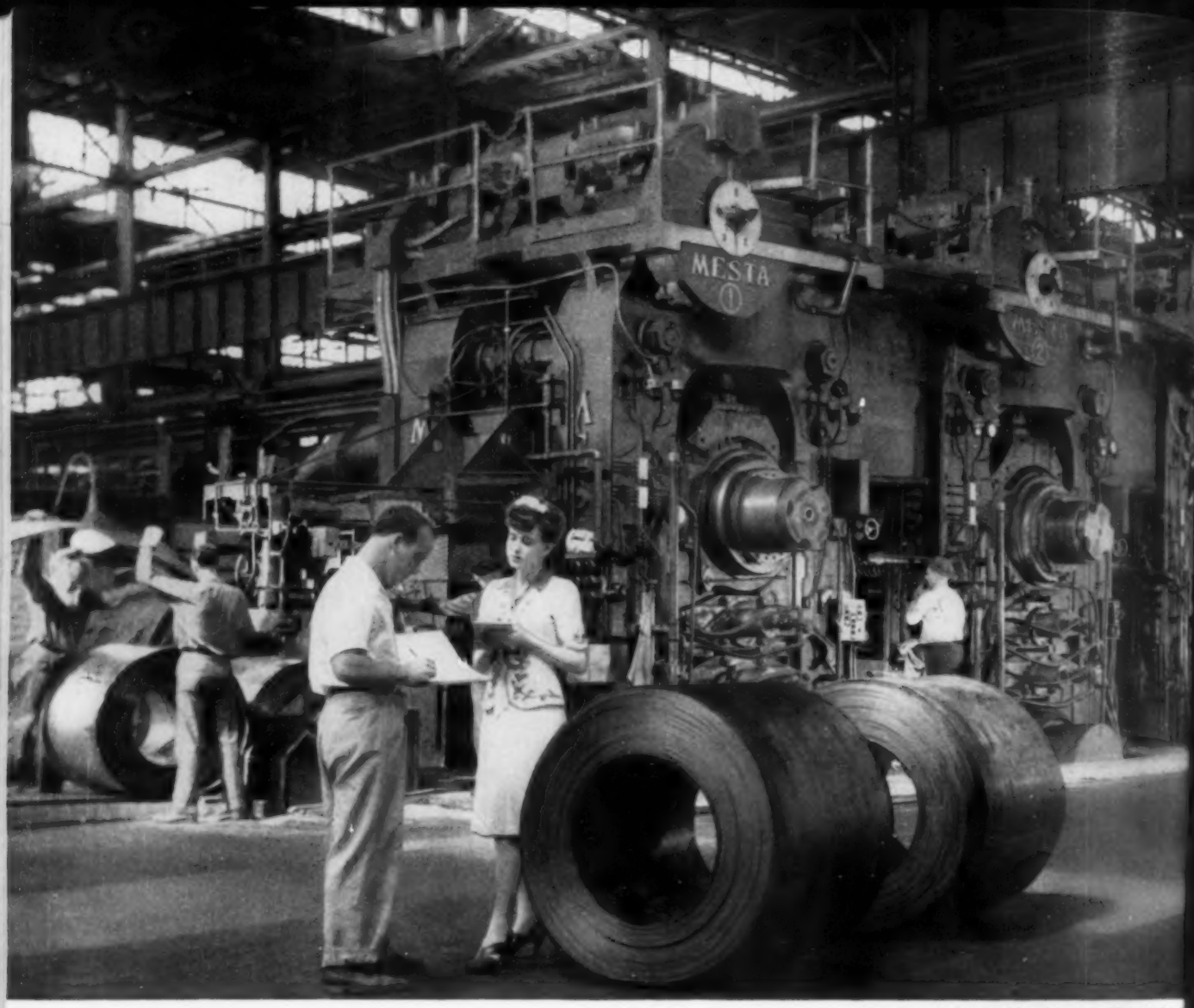


Editor
Ernest E. Thum

Advisory Board
Ray T. Bayless
R. C. Dalzell
A. H. d'Arcambal
W. H. Eisenman
H. J. French
M. A. Grossmann
R. H. Hobrock
Zay Jeffries
C. D. King
C. W. Ruth
F. G. Tatnall
Kent R. Van Horn
R. A. Wheeler


THE AMERICAN SOCIETY FOR METALS

is not responsible for statements or opinions printed in this publication




*One of the Inland cold reduction mills, which re strip to precise thickness and produces a lustrous fi*

# For Finer Steel Products . . . Tomorrow

Consult Inland when plans are started for parts or products which must have the strength, utility, and beauty that can come only from steel sheets and strip.

Inland was among the first to install modern continuous mills. Its engineers and metallurgists have contributed many notable advancements to sheet and strip production methods and quality control —resulting in unsurpassed uniformity, workability, and finish.

Inland experts are ready to help you select the right steel for finer products and economical fabrication—whether the products are for wartime use, or for the markets that will follow Victory.

**Sheets • Strip • Tin Plate • Bars • Plates • Floor Plate • Structurals • Piling • Rails • Track Accessories • Reinforcing Bars**

## INLAND STEEL COMPANY

**38 S. Dearborn St., Chicago 3, Ill.**

**Sales Offices: Cincinnati • Detroit • Kansas City • Milwaukee • New York • St. Louis • St. Paul**

# Post-War Steel and Its Treatment

y Harry W. McQuaid
Manager
rocess and Product Development Division
General Metallurgical Dept.
epublic Steel Corp., Cleveland

*A year ago the Detroit Chapter, ASM, established an annual lectureship in honor of its eminent member William Park Woodside, past president and founder member ASM. Charles F. Kettering was the first lecturer and Harry W. McQuaid the second. This text, very slightly abbreviated, outlines the post-war technological picture as it affects those interested in the selection and heat treatment of steel.*

T GIVES ME great satisfaction to do honor tonight to our old friend, BILL WOODSIDE. More than 25 years ago I first met him in connection with difficulties he was having in casehardening carbon steel camshafts free from soft spots. The test in those days was the file, and a part was either file hard or it was soft, and many and mysterious were the cures which were proposed for eliminating soft work. Bill Woodside had a simple method which indicated where the difficulty lay, and that was to always have in reserve a stock of camshafts which would process *without* soft spots. Whenever the troublesome soft spots arose he would run enough of the tried and tested shafts through to indicate that if the steel in the troublesome shafts was really the same as in the check shafts, no trouble would be encountered. This made it difficult indeed for the steel producer to put the blame on the heat treatment.

Back in those days of soft spots on case-hardened carbon steel, when we were trying to arrive at the factor in steel making which was the basic cause of the difficulty, conditions were considerably different than they are today in the selection of steel and its treatment. The first selection for any carburized part would almost invariably be a plain carbon steel of approximately 0.15% carbon with the manganese 0.30 to 0.60%. If a part was in any way important the steel treater was constantly beset with difficulties due to warpage, cracking, or soft surface in hardening. As a rule steel companies assumed very little responsibility for the results obtained in heat treatment.

The automotive industry had already become a mass producer and it was extremely difficult for the steel treaters to keep up with the demands. Not only were the troubles magnified by variation in steel analysis and methods of making, but the heat treater had constantly to contend with galvanometer-type pyrometers which were, to say the least, extremely temperamental. No heat resisting alloy was available for carburizing boxes and the building of continuous furnaces, so necessary for a large volume of production. Metallurgical knowledge was generally limited to an acquaintance with the iron-carbon diagram as it then existed. Except for development in tool-steels and especially high speed steels, little was known about the transformation phenomena which are so important to the heat treater of today.

We have consequently come a long way since the end of the last war in our knowledge of the factors which determine the proper selection of steel and permit of its successful treatment.

In contrast, let us take a quick glance at conditions as they exist in the automotive industry

today. Heat treating furnaces and baths have become mechanisms of precise operation and dependable reliability. Controls for the heating and cooling cycles have been developed to a degree which permit the steel treater to reproduce any desired cycle without much worry as to harmful variation. Furnace atmospheres have been investigated and developed along scientific lines so that oxidizing and reducing, gas carburizing, annealing, and other heat treating cycles can be conducted exactly. Quenching media have been studied to the point where cooling rates in quenching are also under quite definite and accurate control. All heat treating equipment such as pyrometers and fuel control has been improved to a degree where very little, if any, thought need be given to the mechanical failure if reasonable care is expended in its maintenance. In short, practically every variable has been eliminated or reduced to a harmless point in the mechanics of the modern heat treating operation.

The work on hardenability of steel has progressed to the point where one can predict to a nicety just how far from the surface the fully quenched structure of a given part made from a tested heat of steel will penetrate when quenched from a given temperature in any bath or method. Standardization of hardenability specifications according to chemical analysis and grain size promises to eliminate, practically, the great variations that sometimes upset even the most carefully engineered and conducted heat treat.

The knowledge derived from studies of transformation at constant temperature has given us a new insight into heat treatment. They indicate the necessary program for the production, accurately and regularly, of a desired metallurgical structure to fit a given use. "Stepped transformation treatments", and sub-zero exposure to insure complete transformation, open the door of new promise for the higher alloyed steels.

We seem to have approached an exact science with every processing operation possible of close control and practically automatic operation, so that we can make practical use of our new metallurgical knowledge. With this happy situation in mind let us now see what are the problems in arriving at a sound selection of an analysis and treatment for an automotive application.

## Basis of Selection of Steel

If we are to exercise every possible degree of care in arriving at the best analysis of steel for a given part the task will be much greater than most of you believe. There are many combinations of analyses which will be passable in any given part and it would be difficult indeed to state which one of a final group selected would be the best and most economical. The post-war picture will be further complicated in this respect since we have added to the S.A.E. steels of pre-war days the steels developed to conserve alloys during the present war. Due to various combinations of limits of analysis the actual specifications cover thousands of combinations.

It is impossible in a general discussion such as this to cover all the factors involved in the selection of the best analysis for a given application — even the factors involved in the problem of alloy vs. carbon steel or casehardened vs. high carbon steel. Why, for instance, does one large user find an alloy composition absolutely necessary which sells for a much higher price than that which a competitor finds satisfactory for making the same part? Many factors relate to shop conditions, economics, and past experience rather than on pure metallurgy. I am certain that with increased labor costs and much higher indirect expenses in manufacturing, greater efforts than ever will be made to insist on a steel which will *decrease the final cost*. Management will expect designers and process technicians to be the magicians maintaining a low product cost in the face of higher labor costs and taxes.

In order to meet this pressure for lower costs every possible advantage will have to be taken of the improvements in heat treating, machining and steel making. This means, in my opinion, a new day for technicians. The successful supervisory forces will have men among them thoroughly trained in every phase of engineering involved in the processing of the materials, acquainted with the factors in design which affect its selection and processing, and in addition will have to have available the most modern of equipment and practices. Much attention will be centered upon eliminating dimensional changes and stress concentrations in heat treatment; the drive to eliminate final grinding and other expensive operations by controlled movement in heat treatment will require all our knowledge.

The study of the effect of alloys on the hardenability of carbon steel, and Almen's study of the effect of compression and of tension stresses on fatigue life, have been two important contributions in directing our thinking to more sensible channels. This work has proven that there is a direct relation between the hardenability of heat treated parts and the internal stresses which subtract or add to the operating stresses. This increase or decrease of the operating stresses by internal stresses is probably the most important single factor in determining the

success or failure of a highly stressed heat treated steel part.

This brings up the question of whose domain is most directly concerned. In the past the question of internal stress has always been a responsibility of the metallurgist, who has been greatly concerned with failures in the heat treatment — which show up as losses due to cracking or to severe distortion. Not too much thought has been given to those stresses which cause distortion and sometimes cracking *in use*, during the life of the finished part. The work of Almen has shown that these stresses which are present in the heat treated part may be the most important factor in performance, and hence we find the metallurgist — if he is to be responsible for performance of a part — must control such stresses and be the responsible party in their elimination or control. On the other hand, a designing engineer must be fully acquainted with the extent and location of stresses set up in processing if he is to design a given part intelligently.

This means that both the metallurgist and the designing engineer should have the means and the understanding necessary to evaluate internal stresses which are incidental to the selection of a given analysis of steel and its heat treatment, and also how these stresses are affected by the design. Both must be acquainted with the newer developments in the field of stress analysis, the chosen field of one of the newer engineering societies which meets with the ASM in its annual convention, the Society for Experimental Stress Analysis.

## The Tools of Process Metallurgy

Before we discuss the subject of the selection of a specific analysis to give the lowest cost finished product, we should briefly survey what modern heat treating has to offer and the possibilities of making a product which, while it might have a higher cost of raw metal or heat treating, may be the most economical in the end.

The real basis of all steel selection and treatment is *hardenability*. Hardenability controls physical properties, internal stresses and other reactions which are felt during the whole cycle of processing and in service. We must be careful not to confuse a high surface hardness with the hardenability or ability to reach this hardness to a maximum depth after a given quenching rate. As is well known the maximum surface hardness depends upon the steel's carbon content and — in the engineering steels — is practically independent of the alloy content. The *depth* to which this hardness is obtained with a given carbon content and quenching rate is a function of the alloy content, and is one measure of hardenability. The simple and effective means of measuring hardenability as developed in Detroit is the now universally used Jominy end-quench test, which has permitted us to fit the steel to the quenching medium and vice versa. The Jominy test therefore provides the steel user with a means for determining the depth to which he can expect fully quenched structures under his own special conditions of quenching. It has also provided him with a means of specifying the hardenability which he desires to meet the best requirements of the heat treated part.* But to know the hardenability of a given piece and to be sure that this hardenability is designed to provide the best stress distribution is only one step in the program and does not insure that the quenched structure at the point of maximum stress has the required degree of homogeneity which must be necessary to insure the use of a low factor of safety. To obtain this uniformity in microstructure it is necessary to provide excellent quenching equipment designed for the part in question.

One of the important studies which I feel has not been given the publicity it deserves is the criterion recommended by Robert Schenck, known as the "P" value. This is a simple practical way of indicating the homogeneity of a quenched structure, for it shows the relation between the reduction of area and the tensile strength in steels of high hardness. The value "P" equals $\frac{1}{5}$ of the sum of the tensile strength divided by 100 and the reduction of area multiplied by six. True homogeneity is indicated by a maximum reduction of area, which in turn results from uniform stress distribution throughout the test piece. Any localized point of stress concentration or weakness would result in a premature failure and decreased reduction in area.

Schenck has shown that the straight manganese alloy steels can have a reduction of area in a standard test piece which approaches 50% even when the tensile strength approaches 250,000 psi. In my opinion this indicates what can be done under ideal conditions and it is possible that some day in the future a "P" value of 100 or more will be the basis on which the designer expects to work. That day, however, will only arrive after

*There has been much discussion as to the specification of steel by hardenability limits rather than by chemistry and this has many advantages if intelligently applied. However, the instructions to the steel melter must be in terms of chemistry so that this must be the basic specification. The hardenability test offers a secondary means of specification which should make the application of heats of steel easier.

some rather revolutionary changes are made in steel making processes and perhaps in our heat treatment.

Another important instrument for broadening our knowledge and simplifying our thinking has been the time-temperature-transformation curves developed by Davenport and Bain. With these curves we find ourselves able to visualize what must be done with a given analysis in order to obtain the maximum physical properties in the quenched structures, and especially the procedures to be followed in annealing. They have been especially valuable in indicating the treatment required to prevent the formation of a heterogeneous quenched structure in which we have occasional envelopes of ferrite in a structure which is mostly composed of exceedingly hard and strong martensite. These ferrite envelopes are especially harmful in parts subjected to repetitive stress and act as points of stress concentration. While they have relatively high ductility as compared to the remainder of the quenched structure, they have low strength and under loading are forced to assume most of the load before it can be transmitted to the harder martensitic mass. It results therefore in the seeming paradox that it is the presence of these envelopes of very ductile ferrite which is the primary cause of *low* ductility as shown by impact tests and the reduction of area in the tensile test. Ferrite envelopes can, of course, be the result of inherent segregation in the steel itself rather than poor quenching practice, and their primary cause may be either non-uniform carbon distribution in austenite, or a slow quench.

Such isothermal transformation studies have centered our attention on the advantages of salt bath annealing and liquid bath treatments which permit either transformation at a constant temperature, or delay the transformation in a way which results in quenched alloy steel having more valuable properties. Transformation at constant temperature known as "austempering" is most suited to the high carbon plain carbon steels of relatively light section and at temperatures which are in excess of approximately 500° F.*

The interrupted quench as proposed by B. F. Shepherd, on the other hand, is obtained by cooling alloy steel rapidly from above the critical range to as low a temperature as possible at which it will remain for a considerable time in the untransformed state and then, after a uniform temperature throughout the piece is established, cooling it in air to change austenite into martensite. This process is known as "martempering" and offers great promise where the minimum movement or change in shape is required in the heat treating operation, and for complicated parts where the elimination of grinding would more than pay for the extra cost of the salt bath treatment.

Another new "heat" treating technique has been that of chilling to temperatures approaching —100° F., to insure the complete transformation of all austenite retained in the part as normally quenched. This is especially valuable in steels with considerable alloy. Any retained austenite when transforming later during the tempering operation, sets up stresses which cause distortion and stress concentration in the finished part. Cold treatment is a field which has been quite unexplored for use on the ordinary alloy steel.

In addition to the above developments and the various combinations, we have available advances in case carburizing, dry cyaniding, and salt bath treatments which lend themselves to various products to a degree depending upon their volume and the exact requirements of the designer. It is difficult to see at this time whether any other new and startling changes in heat treating will face us in the next few years. We have already, with our present knowledge of the value of delayed transformations, of new type salt baths and carburizing atmosphere, the possibility of many new combinations in heat treatments which will keep us on our toes for several years to come.

## Problems in Selection

We might now proceed to discuss the problems involved in selecting the most satisfactory steel for a given application. If we were starting with no fixed conviction as to what analysis to use, we would have to settle some questions like the following before we made very much progress:

1. Should we use a carbon or an alloy steel?
2. Should we use a water or oil quenched steel?
3. Should we use a high or a low carbon steel?
4. Should it be carburized or not carburized?
5. Should it be resulphurized for machinability or low in sulphur?

These questions are primarily predicated on what the designer expects and the hardenability desired. They cannot be intelligently answered without full knowledge of service requirements of stress distribution, and necessary abrasion resistance.

Obviously the selection of the best analysis

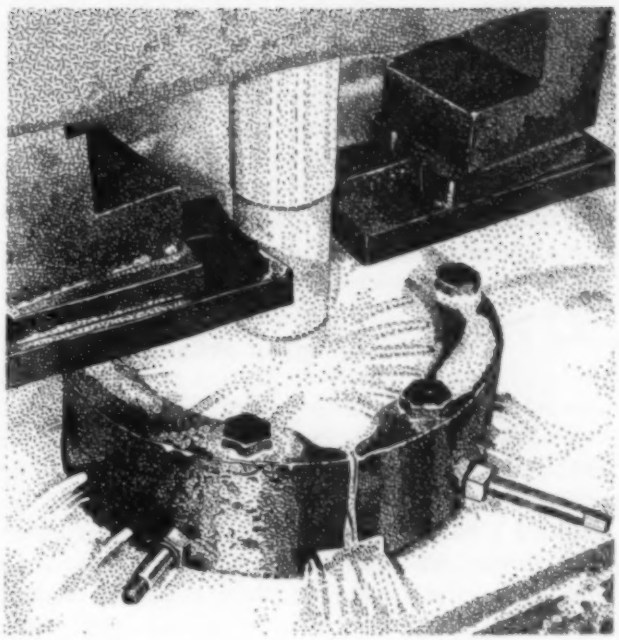
*Editor's Note — This and the other varieties later mentioned by Mr. McQuaid were discussed in considerable detail in *Metal Progress* last month by Arnold P. Seasholtz ("Interrupted" Quenching in Salt Baths).

for a given part is much more complicated than most of us believe. To illustrate the point, consider how the average engineer or metallurgist goes about it. Usually the part is designed in the engineering department, to meet certain demands of the sales or service department; sometimes the design is finished and the steel selected without any consultation whatsoever with the metallurgical or manufacturing departments. The usual approach in such a case would be to use some analysis which has been found satisfactory for a similar part. Another approach is for the engineer to look in some handbook — generally published by an interested alloy producer — and to select an analysis according to some supposed advantageous combination of tensile strength and elongation.

What really should be done is to make the selection on the basis of what will produce the best combination of performance and low cost in the final assembly. After we have agreed with the designer and the manufacturer as to their real requirements, the first place to look would be in the price list of steel! If the analysis selected is to be the most economical we should endeavor to pick a steel in the low cost group. This immediately points to the use of plain carbon steels.

Now, the carbon steels have many things in their favor: They are lower in cost than alloy steels, generally easier to anneal and machine, and they can develop almost any hardness and strength required for automotive parts. The principal criticism lies in their low hardenability, which requires quenching rates equivalent to a fast water or caustic quench. Since water is a quenching medium which is usually easy to obtain and control, the use of water in itself would be an advantage, if it were not for the stresses set up in quenching carbon steel due to the critical speed required in the cooling. This results in non-uniform hardening, with its high inherent stresses, distortion, and the usually unsatisfactory ductility. Inasmuch as practically all automotive parts are so stressed that a relatively shallow depth of hardening is desirable, the low hardenability of carbon steel is not in itself necessarily an adverse feature. That this is true can be demonstrated by comparing the utility of water hardened carbon steel and oil quenched alloy steel axle shafts.

These limitations of the carbon steels are much greater than sometimes appreciated, especially for automotive applications. Any attempt to use them for parts of non-uniform shape or those held to close tolerance will result in a continual battle between quench cracks, distortion



and low fatigue values. In order to overcome these difficulties the simplest and most usual way is to introduce enough alloy into the carbon steel so that the "gate" on the S-curve is opened wide enough to obtain a fully quenched structure when quenched in oil. In doing this we must introduce enough alloy to insure that we will not cross the "ferrite line", and produce a heterogeneous microstructure at any point where the part is subjected to high fatigue stresses. On the other hand, we must avoid surplus alloy, because of the problem which this introduces of having steel with too much hardenability. The extra alloy also involves increased annealing and machining costs as well as higher first cost.

Thus, if we are going to determine intelligently the alloy which we must add to the carbon steel, it becomes necessary to know the full requirements of hardenability and the stress requirements of the finished part in service. Most automotive parts are of relatively small section and since it is important that steel of too high hardenability be avoided (because of their tendency toward lower fatigue resistance) it will be found that very little alloy is usually necessary in addition to the usual carbon and manganese of carbon steel. In fact, what we are really seeking is the lowest alloy, oil-quenching steel which will produce the finished part at the lowest cost to the manufacturer as well as the user. In the normal automotive design, with the possible exception of heavy duty truck applications, it will soon be found that after the proper carbon has been selected to insure the hardness required at

the surface, small additions of manganese, molybdenum, nickel or chromium will give the desired results. It has been demonstrated many times that the straight manganese type, with proper hardenability and quality, will produce satisfactory parts for the modern automotive application; the same has been demonstrated for the carbon-molybdenum steels, the manganese-molybdenum, the nickel-molybdenum, and other combinations including chromium.

## Specific Effects of Alloys

According to its producer, each alloy has some outstanding value in a given analysis. While this is true to a degree, it is not hard to demonstrate that automotive engineers would be able to struggle along without any particular alloy except manganese. There is no doubt that one of the more valuable alloys is nickel; in my opinion, its prime value is as an important strengthener of the ferrite, and hence is a life saver for poorly quenched alloy steels. (As remarked above, the criterion of fatigue resistance and ductility, especially in the higher hardness ranges, is the ferrite which develops from the low cooling rate of the poorer quench.) It is especially valuable in open tank oil quenching where even under the best conditions it is difficult to obtain a fully homogeneous martensitic structure.

Manganese is just as valuable in improving the properties of the quenched steel, although its effect on the ferrite is less marked than nickel. Its main function is to increase hardenability, and to give the hardener more time for handling the piece from the furnace to the quench. The combination of manganese and nickel is extremely important in this respect, especially in the direct quenching of carburized parts from the carburizing temperature.

Molybdenum is quite similar in its properties to manganese and is especially valuable in increasing the permissible time between furnace and quench. It is as powerful a hardening medium as manganese, and in combination with manganese or nickel or both has demonstrated its importance in automotive steels. Both nickel and molybdenum are alloys which are not oxidized in remelting and hence are recovered from the scrap. For this reason, whether we wish it or not, the production of steel without these two elements is going to be just about impossible except in very limited quantities.

Chromium is also one of the most valuable additions, especially where resistance to abrasion and high surface hardness are the most desirable requirements in the finished parts. For this reason it has been used extensively in ball bearings and gears. It has less advantage in direct quenched carburized work because of the tendency of the excess carbides to precipitate at high temperatures. In carburized steel, however, it is an important means of obtaining higher carbon concentration in the surface and higher Rockwell readings.

In my opinion it is not too difficult to arrive at a satisfactory answer as to what steel to select for most automotive applications. Since most parts require relatively low hardenability, oil quenching becomes desirable. We should therefore select a carbon steel with enough added alloy to obtain the desired hardenability, and since nickel, molybdenum and chromium are going to be with us whether we wish it or not, the steel specified should contain nickel, molybdenum and chromium. If we add the effect of these elements to that of the manganese added by the steel maker to control sulphur and oxygen, we soon find that we can make a very desirable steel for most applications out of combinations containing carbon, manganese, nickel, molybdenum and chromium, and that it does not take very much of the chromium or molybdenum to obtain the desired hardenability.*

Thus, we arrive at the conclusion that since nickel, molybdenum and chromium will be present in most of our heats of steel, we should make up our oil hardening, low alloy grade by combining these additions in such percentages as can be easily controlled by the steel maker and which will give the user his necessary hardenability. This, of course, has already been done for us in the NE grades (frequently called "triple steels"); the NE8600 specification is typical, it contains 0.80% Mn, 0.55% Ni, 0.50% Cr and 0.20% Mo, and this analysis, in my opinion, can be used as a good start for most of our selections.

*There has been much discussion of the value of adding special alloys such as boron, or boron in combination with aluminum, vanadium, titanium or zirconium to carbon steels to obtain the desired hardenability. These "addition alloys" — so called — all appear to depend for their success on being added to a fully killed steel and hence are always used in connection with high aluminum additions. To the steel maker this immediately presupposes full alloy practice or special requirement carbon steel practice, with oxidation control and special ingot practice. Since, as noted above, the residuals of nickel, molybdenum and chromium are going to be with us because of alloys in the scrap, the actual control of carbon steel hardenability — or even alloy steel hardenability — when boron is added is going to be almost impossible, except by the use of special alloy-free scrap and pig iron.

## Summary of Perfected Treatments

Having discussed the type of steel most likely to be available we might now touch briefly on its probable treatment. To be specific, let us discuss the advantages of a treatment such as carburizing (or rather "casehardening"). Originally casehardening was developed to permit the use of a soft, low carbon, easily machined steel and to obtain the resistance to wear of a hard steel and its desired strength.

As we see it now, however, the picture has changed; ease of machining is a secondary advantage. The fully casehardened part offers advantages in parts that must resist fatigue because the surface is in compression after heat treatment and these inherent compression stresses neutralize a sizable portion of the tension stresses resulting from the loading. This is extremely important in most automotive applications.

The initial compression stresses at the surface are offset by equal tension stresses at some distance below the surface. We must carefully watch our case-core combinations to see that when compression stresses (as in ball and roller bearings) are increased at the surface the part does not fail in tension below the surface. Bearing users ordinarily describe this type of failure as "pitting". In such applications the core hardness must be high enough to provide increased tensile strength just under the case.

Time does not permit the full discussion of the selection of a heat treating cycle which would be the best from all angles. Equipment is now available for making any heat treatment a continuous operation. The use of the lower alloyed steels of controlled hardenability, as discussed above, lends itself to continuous annealing, either of the isothermal type in salt baths, or in stepped continuous furnaces. Such equipment should be readily adapted to any steel selected. Certainly we can look forward to a combination of continuous carburizing and martempering operation, with a carefully worked out straightening operation after the temperature equalizing treatment. Already this general plan has shown most interesting promise in practice.

Combined with our study of what analysis and treatment is best for a given part must be our studies of stresses set up in processing and their effect on the performance of the finished part in the final assembly. It is the metallurgist to whom the failed part is taken and who is asked to explain the failure and to recommend action to prevent further failures. He is usually told that some change in the processing or some increase in inspection might be permitted if the failure is one of minor importance. If the failures are serious, and especially if they affect the sales resistance, he is told to go to almost any extreme. There is seldom any expectation that he will suggest changes in design — in fact the designer usually assumes that the full responsibility is on the steel or its treatment, and the metallurgical department should be held solely responsible.

Many engineers (and metallurgists as well) are of the "static" type; their ideas, designs and calculations are based upon formulations which are primarily of the equilibrium type, and they are often quite confused when it comes to the interpretation of dynamic loading. This must change. Successful metallurgists and engineers who are responsible for performance will have to become thoroughly acquainted with the stresses set up in the mechanisms they are working with in a range where the life is definitely limited to a predetermined time or duty. Economical life rather than indefinitely long life will be the aim.

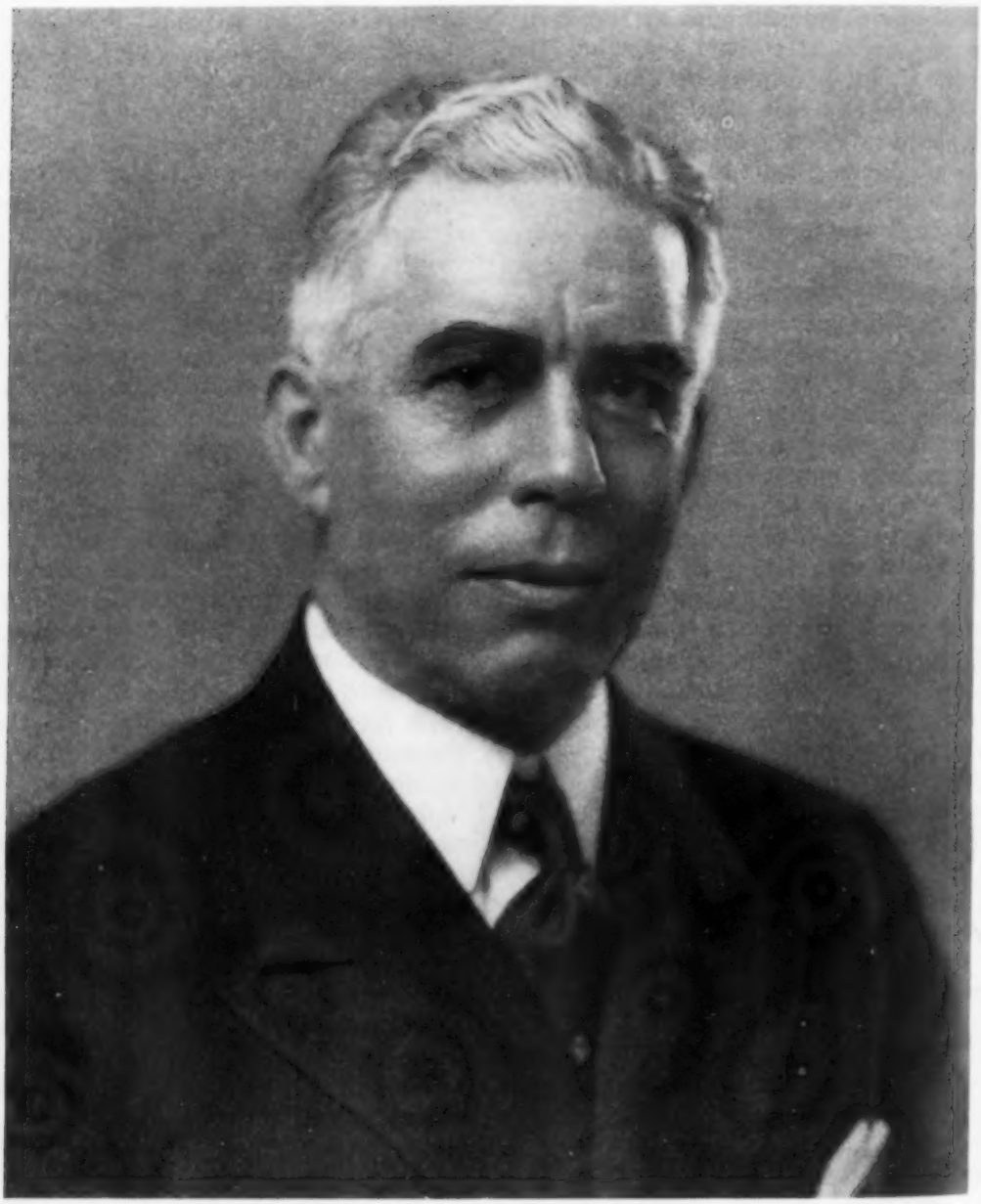
Experience which the automotive industry has had in the production of aircraft engines will impress itself upon the industry in due time. Its first effect will probably be upon the designer, who will endeavor to work to a much lower factor of safety in automotive and tractor parts. The low factor of safety in aircraft engineering has thrown greatly increased reliance on the uniformity of material and workmanship, since failure in an aircraft engine has much more important effects than the failure of an automotive engine.

Therefore a new day is dawning for the technician responsible for the selection and treatment of steel. Many factors in the processing not directly connected with analysis or heat treatment have already been placed in the hands of the metallurgist. He is quite often responsible for machinability, corrosion effects, appearance and even perhaps lubrication and resistance to high temperatures.

In the new day the pressure for more uniform material and workmanship combined with more accurate design and the lowest possible cost will center attention to an unheard-of degree on the quality of steel as well as the quality of the engineer and the metallurgist. When this day arrives, as it surely will, the problem of selecting automotive steel will be much more critical than at present and will probably cause a largely increased use of electric furnace steel.

It is certain that requirements for all engineers interested in the production and processing of steel will continuously increase in the months to come. We should all feel thankful indeed for the opportunities offered by the full field of automotive metallurgy.

# 1942 Recipient, ASM Medal for the Advancement of Research



**Robert Crooks Stanley**

Chairman & President, The International Nickel Company of Canada, Limited

ACCORDING to all our popularly accepted notions of business achievement, ROBERT C. STANLEY should have reached the zenith of his career in 1922 when, only 20 years out of college, he became president of the International Nickel Co., for it is commonly assumed that when a man becomes head of a great corporation he is finally in a position to delegate the hard work to others, to relax, and, in time, to gracefully atrophy. (There is extant, indeed, a sufficient number of corporation presidents of varying degrees of obsolescence to bolster this belief.)

In Stanley's case, however, it is safe to say that his hard work and responsibilities didn't really *begin* until then, and that even today, 22 years later, he has not yet reached the peak of his performance. One reason for this is his aggressive temperament: He is too alert, both physically and mentally, to lapse into complaisance. Another reason — equally important — is that the presidency of International Nickel is no job for a figurehead, and neither Stanley nor anybody else could have survived the past two decades with his company intact without possessing and using unusual energy and judgment.

Stanley can take some satisfaction in the fact that his rise in the business world was not brought about by financial connections or through the processes of nepotism. His choice as head of the company was dictated by necessity. In 1922 the nickel industry was young and undeveloped and economically at the mercy of the unpredictable whims of wars, depressions, and inflation. Prior to and during World War I much of the nickel went into armament steels. The majority of the *potential* users of nickel were uninformed about the metal and indifferent to it. Thus, the company — if it were to develop — had to have a man over it who was not only an experienced mining and metallurgical engineer but who also had the capacity to understand and overcome the worldwide economic problems that faced the metal industry.

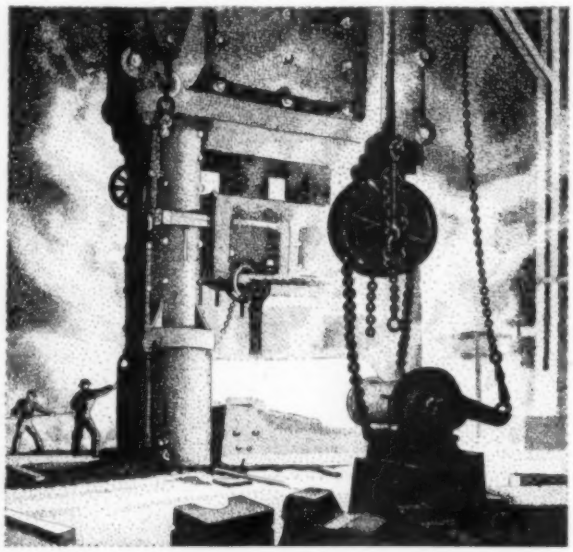
One of the first things he did then was to organize a research and sales engineering department of technical men who were told to study every possible peacetime use for nickel in commerce and industry, and to devise alloys and products to suit these needs. Moreover, these technical men became evangelists of nickel, so to say, by giving free aid-and-comfort to companies with metallurgical problems and, wherever practicable, adapting nickel to their needs. So successfully did this promotional and research team perform, that by 1929, the company had almost completely made the change from swords to plowshares, had taken over the British owned Mond Nickel Co. and its production showed a sevenfold increase.

Wisely, Stanley never relaxed his research and development program, even during the depression, and was able to guide his company through the dog days of the early 1930's with happier results than those experienced by many other large companies. Part of the company's good sailing during the depression came from the sale of various metals found in its mines in association with nickel ores. These include copper, silver, gold and the so-called platinum group. In many years, copper alone has provided a quarter of the company's revenue and the precious metals have accounted for another quarter. (At present the company is the world's largest supplier of platinum.) Naturally, research and development of these subsidiary metals has been carried on in the same way.

It is interesting to note that Stanley's program of research and development was going full blast back in the distant days when most firms considered such activities to be a non-income-producing luxury which they could afford only after they had earned their dividend requirements. It is primarily because of Stanley's long and fruitful pushing of metallurgical research that he was awarded the ASM's gold medal for the advancement of research during the 1944 meeting of the National Metal Congress in Cleveland last month.

ROBERT CROOKS STANLEY was born in 1876 in Little Falls, N. J., a pleasant village which is best described as being a suburb of Montclair, which, in turn, is a suburb of Newark, a suburb of New York City. He attended the local public schools, and still has a faded photograph of the Montclair High School football team on which he played. He studied engineering at Stevens Institute of Technology in Hoboken, N. J., becoming a "Mechanical Engineer" in 1899, and went from there to the Columbia University School of Mines where he earned the degree of Mining Engineer

in 1901. Since then he has received honorary degrees from Stevens, Columbia, and the Rensselaer Polytechnic Institute. His first job was with the Orford Copper Co. and the following year he became assistant superintendent of the American Nickel Works in Camden, N. J.—pretty good for a youngster one year out of college! Both of these companies became subsidiaries of the International Nickel Co. when it was organized in 1902.



When Stanley was superintendent of the latter firm's Bayonne plant in 1905, he made an experiment that led to the development of Monel metal (named in honor of the then president of the company). He proposed that the copper and nickel minerals, which occurred together in a substantially constant proportion in the Canadian ores, be smelted directly into an alloyed metal instead of being reduced separately only to be mixed again. The resulting metal, often called a natural alloy, has been a standard item ever since, widely used in severe services for its unusual resistance to corrosion.

In 1912 he was made general superintendent of the parent nickel company—an event which he celebrated by getting married—and in 1918 he became vice-president in charge of all operations. Four years later he was elected president. Today, in addition to being president, he is also chairman of its board of directors.

Stanley and his wife, the former Alma Guyon Timolat, live in the Dongan Hills section of Staten Island. From this vantage point he is roughly halfway between the company's Bayonne Works across the Arthur Kill in New Jersey, and the company's executive offices at 67 Wall St., which he can almost see across the ship-laden waters of New York Harbor. Mrs. Stanley spends much of her time working with the Staten Island American Red Cross unit and attending to her various philanthropic ventures. Their two children are now grown up, a son in the wars, a daughter a homemaker.

It is typical of Stanley to keep in constant personal touch with all parts of his widespread organization. There is very little that he doesn't keep his eye on, and, as nearly as it is possible for one man, runs the huge organization under his supervision. His activities extend to such recondite matters as the company's institutional advertising. Some months ago he attended a luncheon of a church organization and became extremely interested in a discussion of the sort of peace we should have in the world after this war. Out of this came a plan of spreading the idea of a "just and durable peace" to the grassroots of Canada and this country by means of advertisements in newspapers, country weeklies, and farm papers. As a result, the inhabitants of scores of communities, some of them remote, found in their papers a series of ads which urged them to think about and discuss among themselves the kind of a peace that will best benefit the entire world. These messages were largely edited by Stanley himself and some of them were rewritten by him. In none of the ads did Stanley's picture, name, or "personal message" appear—a triumph of good taste. Certainly, this campaign was a far better way to do a public service than the millions of dollars worth of advertising that has been put out by some manufacturers merely to eulogize their wares.

Despite his opportunities for fanfare and personal publicity, Robert Stanley is content to work hard and let others do the talking. He is friendly in a slightly shy way but no back slapper. No stranger would spot him, in a crowd, as a "big executive". When he gets a chance he goes salmon fishing in Canada, and he is an interested follower of boxing and other sports. He gets along with equal ease with Big Joe the foundry molder and with the Rt. Hon. Viscount Weir of Eastwood, P.C., G.C.B., a director of his company.

Ultimately, the most searching test that any business executive's character and reputation can be subjected to is the considered opinion of the boys in the bookkeeping department. Hoping to get the real dope, this writer asked an acquaintance in that department about Stanley.

The answer when appraised as coming from such a source, could be rated as *enthusiastic*: "Why," he said, frowning, "he's not a bad guy . . . not a bad guy at all."

# Methods for Computing Springback When Bending Stainless Steel

By C. M. Brown, W. O. Binder,
Research Metallurgists
and Russell Franks
Chief Metallurgist
Union Carbide and Carbon Research Labs.
Niagara Falls, N. Y.

*Elastic theory of sheet metal bending and forming has been worked out by engineers in the aircraft industry, and tables, graphs and alignment charts for solving problems in die design have been prepared for the strong aluminum alloys. In this article similar data are presented for 18-8 and 17-7 steel sheet, both in annealed condition and cold rolled to various high yield strengths.*

STAINLESS STEELS generally used in light weight structures are austenitic in character and are cold rolled to thin sections to obtain the necessary strength. They are designated as 18-8 and 17-7, where the first number represents roughly the percentage of chromium and the second the percentage of nickel. Both steels have been applied in light weight, high strength structures using sections below 0.01 in. thick up to and beyond 0.05 in. thick. As is well known, the percentage of cold reduction applied to the steels is controlled so as to obtain material of different strengths. The mutual relationships of composition, degree of cold work, and tensile properties have been discussed by Krivobok and Lincoln in *Transactions* for 1937, p. 637. Among the many articles describing the applications of such alloys to aircraft construction may be mentioned the one in *Mechanical Engineering*, 1942, p. 589, by Franks and Binder, and the one in *Iron Age* for Jan. 30, 1941 by Lincoln.

**Table I — Composition of the Steels**

| STEEL | C | SI | MN | CR | NI |
|---|---|---|---|---|---|
| 18-8 *A* | 0.10 | 0.55 | 0.50 | 18.45 | 8.79 |
| 17-7 *B* | 0.13 | 0.37 | 1.29 | 17.33 | 7.14 |
| 18-8 *C* | 0.10 | 0.55 | 0.50 | 18.45 | 8.79 |
| 18-8 *D* | 0.07 | 0.37 | 0.67 | 18.47 | 9.02 |
| 17-7 *E* | 0.12 | 0.36 | 1.26 | 17.44 | 7.18 |
| 18-8 *F* | 0.07 | 0.53 | 0.61 | 18.54 | 9.01 |
| 17-7 *G* | 0.12 | 0.33 | 1.12 | 16.96 | 7.07 |

The data of Table II, page 1078, are typical of the mechanical properties of the different steels both in tension and in compression, as annealed and in the different conditions of hardness. A review of this and other data, which include information on steels as cold rolled, and on the same after heat treatment, published by Franks and Binder in *Transactions* of the American Institute of Mining and Metallurgical Engineers, Iron and Steel Division, 1940, p. 433, shows that the 18% chromium, 8% nickel steel has, in tension, yield strengths at 0.2% offset between 35,000 and 150,000 psi., with good ductility. The yield strength for the steel in compression is about 35,000 psi. for the annealed condition, and increases on cold rolling up to about 120,000 psi. in the longitudinal direction to rolling, and up to about 150,000 psi. for the transverse direction.

Data for the 17% chromium, 7% nickel steel show that in tension the yield strength can be increased from about 33,000 psi. in the fully annealed condition to about 165,000 psi. in the full hard condition without greatly sacrificing

**Table II — Mechanical Data for 18-8 and 17-7 (0.035-In. Strip)★**

| Steel | Per Cent Cold Reduction | Condition | Direction | Tension | | | | | Compression | | | | Rockwell Hardness |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Initial E x $10^{-6}$, psi. | Proportional Limit, 0.01% Offset, psi. | Yield Strength 0.2% Offset, psi. | Tensile Strength, psi. | Elongation, % in 2 in. | Initial E x $10^{-6}$ psi. | Proportional Limit, 0.01% Offset, psi. | Yield Stress 0.2% Offset, psi. | Buckling Strength, psi. | |
| 18-8 Steel *A* | 0 | A | L | 29 | 29,000 | 36,000 | 94,500 | 61 | 28 | 19,000 | 36,000 | 50,250 | B-80 |
| | 0 | A | T | 29 | 31,000 | 34,000 | 93,700 | 61 | 28 | 13,000 | 36,000 | 50,000 | .... |
| | 20 | 1 | L | 27 | 44,000 | 121,000 | 139,300 | 22 | 26 | 29,000 | 74,000 | 120,400 | C-29 |
| | 20 | 2 | L | 27 | 68,000 | 128,000 | 141,200 | 20 | 28 | 57,000 | 94,000 | 129,400 | C-30 |
| | 20 | 1 | T | 28 | 57,000 | 113,000 | 138,500 | 17 | 27 | 63,000 | 121,000 | 145,000 | .... |
| | 20 | 2 | T | 29 | 71,000 | 117,000 | 141,800 | 14 | 28 | 75,000 | 126,000 | 147,500 | .... |
| | 35 | 1 | L | 26 | 68,000 | 131,000 | 155,300 | 15 | 26 | 36,000 | 95,000 | 151,800 | C-36 |
| | 35 | 2 | L | 27 | 84,000 | 155,000 | 173,400 | 11 | 27 | 56,000 | 118,000 | 158,000 | C-37 |
| | 35 | 1 | T | 30 | 72,000 | 130,000 | 166,200 | 11 | 27 | 71,000 | 149,000 | 183,110 | .... |
| | 35 | 2 | T | 31 | 80,000 | 147,000 | 178,700 | 10 | 29 | 100,000 | 169,000 | 193,000 | .... |
| 17-7 Steel *B* | 0 | A | L | 29 | 21,000 | 33,000 | 117,800 | 68 | 28 | 23,000 | 40,000 | 57,800 | B-85 |
| | 0 | A | T | 29 | 24,000 | 33,000 | 113,500 | 62 | 29 | 19,000 | 44,000 | 57,400 | .... |
| | 25 | 1 | L | 28 | 47,000 | 127,000 | 165,200 | 24 | 26 | 38,000 | 96,000 | 151,400 | C-38 |
| | 25 | 2 | L | 29 | 55,000 | 142,000 | 167,000 | 23 | 28 | 68,000 | 119,000 | 156,100 | C-39 |
| | 25 | 1 | T | 30 | 65,000 | 124,000 | 170,500 | 17 | 28 | 76,000 | 143,000 | 172,200 | .... |
| | 25 | 2 | T | 30 | 72,000 | 134,000 | 167,200 | 18 | 29 | 96,000 | 154,000 | 177,500 | .... |
| | 35 | 1 | L | 26 | 60,000 | 164,000 | 196,000 | 15 | 26 | 51,000 | 139,000 | 184,500 | C-43 |
| | 35 | 2 | L | 27 | 81,000 | 180,000 | 198,000 | 14 | 27 | 85,000 | 161,000 | 201,200 | C-44 |
| | 35 | 1 | T | 30 | 61,000 | 138,000 | 201,000 | 10 | 27 | 87,000 | 185,000 | 214,300 | .... |
| | 35 | 2 | T | 30 | 78,000 | 170,000 | 202,000 | 10 | 29 | 124,000 | 200,000 | 218,500 | .... |

A = Annealed.
1 = Cold rolled.
2 = Cold rolled, heat treated 24 hr. at 525° F. (275° C.) and air cooled.
L = Longitudinal to rolling direction.
T = Transverse to rolling direction.

ductility. In compression, 17-7 exhibits yield strengths in the direction of rolling up to slightly less than 140,000 psi., whereas in the transverse direction it has yield strengths as high as 180,000 psi. in the cold rolled condition.

The data of Table II further illustrate that heat treating the steels at 525° F. (275° C.) after cold rolling produces a definite improvement in yield strength without affecting ductility. This improvement is obtained in tension and in compression in both directions to rolling, and is of importance to engineers who are interested in working their designs to the utmost safe limit.

One of the most important characteristics of the cold rolled stainless steels is their relatively high fatigue strength, which is illustrated by the data in Table III. It is shown that the 18-8 steel *D* with a tensile yield strength of 115,000 psi. has a fatigue strength in the cold rolled condition of about 60,000 psi., and after low temperature heating the fatigue strength is increased to 65,000 psi. With 136,000 psi. yield strength the 17-7 steel *E* has a fatigue strength of 65,000 psi. in the cold rolled condition, which is increased to about 70,000 psi. after heating to 525° F. (275° C.). When its yield strength is raised to about 157,000 psi. the cold rolled 17-7 exhibits a fatigue strength of slightly over 70,000 psi., and after heat treating it approaches 80,000 psi., which is considered normal for the steel.

## Cyclic Tests Into Plastic Region

These steels have been fabricated into many different types of light weight structures. A well known example is streamlined railway coaches. The usual procedure consists of forming the parts to the necessary shape and fastening them together either by spot welding or by arc welding. The die design and the forming operations have been carried out according to more or less empirical methods, which have been time consuming and in some respects troublesome. Consequently it has been proposed that information obtained

★"The Stress-Strain Characteristics of Cold Rolled Austenitic Stainless Steels in Compression, as Determined by the Cylinder Test Method," by R. Franks and W. O. Binder, *Proceedings*, A.S.T.M., June 1941, p. 629, and "Tensile and Compressive Properties of Some Stainless Steel Sheets," by C. S. Aitchison, Walter Ramberg, L. B. Tuckerman and H. L. Whittemore, National Bureau of Standards Research Paper No. 1467.

from cyclic stress-strain testing in tension may be of help in solving some of the problems encountered in die design and sheet metal forming operations, in the same way as the data already published on these characteristics for certain of the aluminum alloys used in similar light weight, high-strength structures.*

Such tests were conducted on both the 18-8 and the 17-7 steels in the annealed condition, and after cold rolling to different degrees of strength. All tests were made on steels in the longitudinal direction to rolling.

The samples tested were in the form of standard A.S.T.M. strip tensile specimens prepared from 0.035-in. material. Normal testing procedures were employed, using a hydraulic testing machine to apply loads, and suitable extensometers to measure the accompanying strain. Beyond the final yield strength, strain measurements were made using dividers over a 2-in. gage length. The testing speed in all cases was low enough to allow positive and negative creep to take place. In the cyclic tests, the specimens were stressed somewhat beyond the 0.2% offset yield strength, and the stress released. The specimen was then restressed to approximately a new 0.2% offset yield strength, the stress again released, and so on for several cycles of stress.

Table IV contains data obtained from cyclic stress-strain tests. The stress values shown in this table are based on the original cross-sectional areas of the specimens, and are termed "nominal" stresses. Stress-strain curves are shown in Fig. 1 and 2. Three curves are plotted on each chart. The data represented by Curve A are the nominal stress-strain data for the complete test. Curve B shows the nominal stress vs. strain relation in

**Table III — Endurance of 18-8 and 17-7 (0.035-In. Strip)**
Based on 20,000,000 Reversals of Stress

| Steel | Cold Rolled Condition | | | Endurance After Heat Treatment *(c)* |
|---|---|---|---|---|
| | Tensile Yield *(a)* | Test Direction *(b)* | Endurance Limit | |
| 18-8, *C* | 36,000 *(A)* | L | 35,000 | .... |
| *D* | 115,000 | L | 58,000 | 65,000 |
| *D* | .... | T | 60,000 | 65,000 |
| 17-7, *E* | 33,000 *(A)* | L | 45,000 | .... |
| *E* | 136,000 | L | 70,000 | 72,500 |
| *E* | .... | T | 62,500 | 67,500 |
| *E* | 157,000 | L | 72,000 | 76,000 |
| *E* | .... | T | 72,000 | 76,000 |

*(A)* means "in annealed condition".
*(a)* Tensile yield strength at 0.2% offset, in psi.
*(b)* L = Longitudinal to rolling direction.
T = Transverse to rolling direction.
*(c)* Heated 24 hr. at 525° F. (275° C.) and air cooled.

*"Elastic Theory in Sheet Metal Forming Problems," by F. R. Shanley, *Journal of Aeronautical Sciences*, July 1942, p. 313; "Mechanics of Sheet Metal Bending," by William Schroeder, *Transactions* of the A. S. M. E., Nov. 1943, p. 817; "Fabrication of Aircraft Parts," by F. C. Hoffman, *Iron Age*, Jan. 20, 1944, p. 60.

**Table IV — Summary of Cyclic Tension Tests on Cold Rolled 18-8 and 17-7**
Tested in Longitudinal Direction of Strip 0.035 In. Thick

| Steel | Initial $E \times 10^{-4}$ | Yield (0.2% Offset) | Tensile Strength | Elongation | Remarks |
|---|---|---|---|---|---|
| 18-8 *D* | 28 psi. | .... | | | First cycle, not taken to 0.2% offset. |
| | 30 | 38,000 psi. | 98,200 psi. | | Second cycle. |
| | 25 | 39,000 | | 58.5% | Third cycle, carried thru to failure. |
| 18-8 *D* | 28 | 115,000 | | | First cycle. |
| | 27 | 119,000 | | | Second cycle. |
| | 29 | 122,000 | 130,300 | 26.0 | Third cycle, through to failure. |
| 18-8 *F* | 29 | 126,000 | | | First cycle. |
| | 26 | 138,000 | | | Second cycle. |
| | 28 | 142,000 | | | Third cycle. |
| | 28 | 143,000 | 152,800 | 22.0 | Fourth cycle, through to failure. |
| 17-7 *G* | 29 | 124,000 | | | First cycle. |
| | 27 | 139,000 | | | Second cycle. |
| | 28 | 143,000 | | | Third cycle. |
| | 28 | 145,000 | 185,500 | 29.0 | Fourth cycle, through to failure. |
| 17-7 *G* | 29 | 151,000 | | | First cycle. |
| | 28 | 167,000 | | | Second cycle. |
| | 27 | 171,000 | | | Third cycle. |
| | 26 | 172,000 | 191,400 | 20.5 | Fourth cycle, through to failure. |

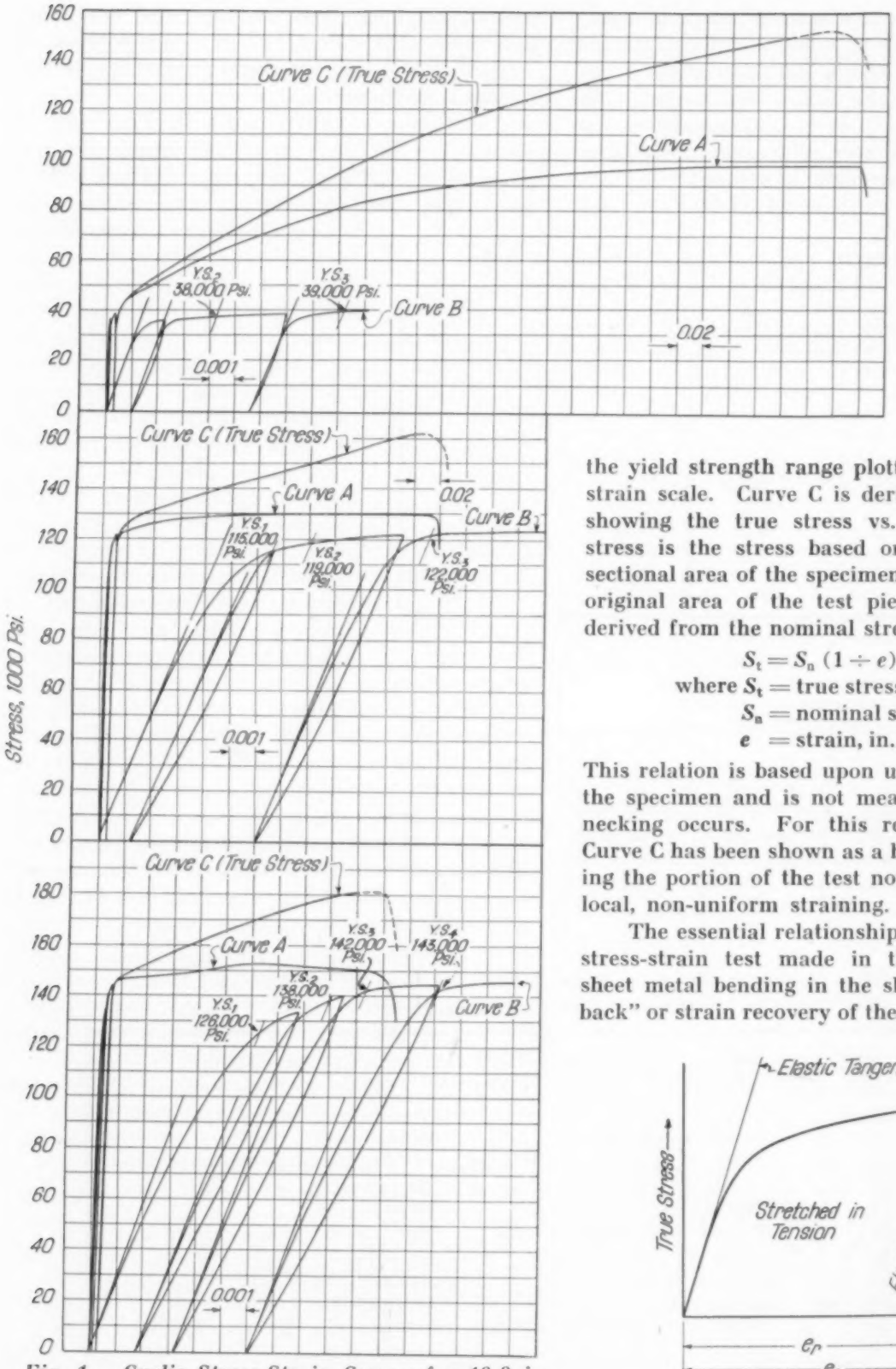



*Fig. 1 — Cyclic Stress-Strain Curves for 18-8 in the Annealed Condition (Top Diagram), and Cold Rolled to 115,000 and to 126,000 Psi. Yield Strength (Respectively Middle and Bottom). Note expanded horizontal scale for curves showing elastic and plastic action during cyclic testing. Curves A and B are computed on original cross section of test piece; curves C on sections uniformly reduced before necking occurs*

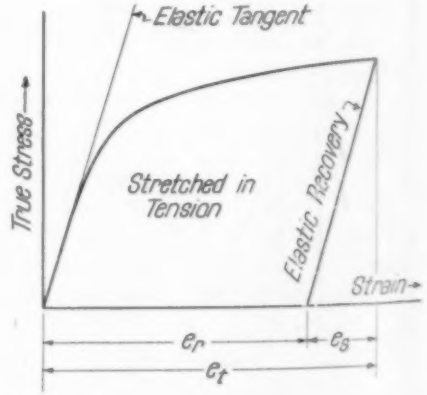
the yield strength range plotted on an expanded strain scale. Curve C is derived from Curve A, showing the true stress vs. strain. The true stress is the stress based on the actual cross-sectional area of the specimen rather than on the original area of the test piece. True stress is derived from the nominal stress as follows:

$$S_t = S_n (1 \div e)$$

where $S_t$ = true stress, psi.
$S_n$ = nominal stress, psi.
$e$ = strain, in. per in.

This relation is based upon uniform straining of the specimen and is not meaningful when local necking occurs. For this reason a portion of Curve C has been shown as a broken line, indicating the portion of the test noticeably affected by local, non-uniform straining.

The essential relationship between the cyclic stress-strain test made in the laboratory and sheet metal bending in the shop is the "spring-back" or strain recovery of the metal upon release

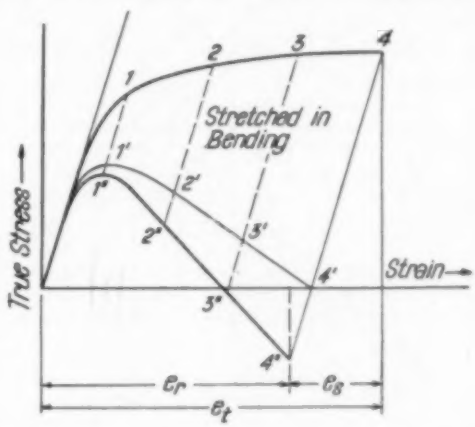



of applied load. Such strain recovery is well known within the elastic range, in which stress and strain are considered to be proportional; it also occurs to a certain extent in the plastic range of strain. In the extreme case — that is, at the

point of fracture in the cyclic stress-strain test — elongation is greater before than after failure.

Near the bottom of the left hand column on page 1080 is a diagrammatic representation of strain recovery in metal upon the release of load in the pure tension test. The metal has been stressed to produce a total strain $e_t$, and springback takes place upon release of load in an amount $e_s$, leaving a permanent plastic deformation or residual strain $e_r$. A similar strain relationship exists in the fibers of a bend. The strain in the fibers of the cross section of the bend varies from maximum tension at the outer fiber to zero at the neutral axis, and to maximum compression at the innermost fiber. The recovery of these fibers, which have been bent by an applied load, results in an angular springback when the bending load is removed. A rather complete exposition of those facts was presented by Brewer in *Metal Progress*, page 441 of September 1943 issue, in a discussion of residual stresses in wire loops, and by Schroeder in *Transactions* A.S.M.E., page 817 of November 1943.

It is necessary to modify this simple but fundamental example of a tension test piece to describe accurately the bending process. For simplicity, only the tension side of the bend need be considered, and the second diagram shows the strained fibers, 1, 2, 3, and 4 equally spaced between the neutral axis and the outer surface.




These fibers are strained in tension proportionally to their distance from the neutral axis, but the *stresses* at these points of strain are not proportional to the distance to the neutral axis, but are zero at the neutral axis and reach a maximum at the outer fibers, in accordance with the stress-strain curve for the material. It would be expected from previous discussion that, upon removal of the bending load, recovery would place the outer fiber at 4', the position of zero stress; the other fibers having proportional amounts of strain as indicated by 1', 2' and 3'. However, this does not represent equilibrium conditions. Internal stresses, as at 1', 2', and 3', are influential in causing further recovery in 4' to a point 4" so that the resulting sum of the

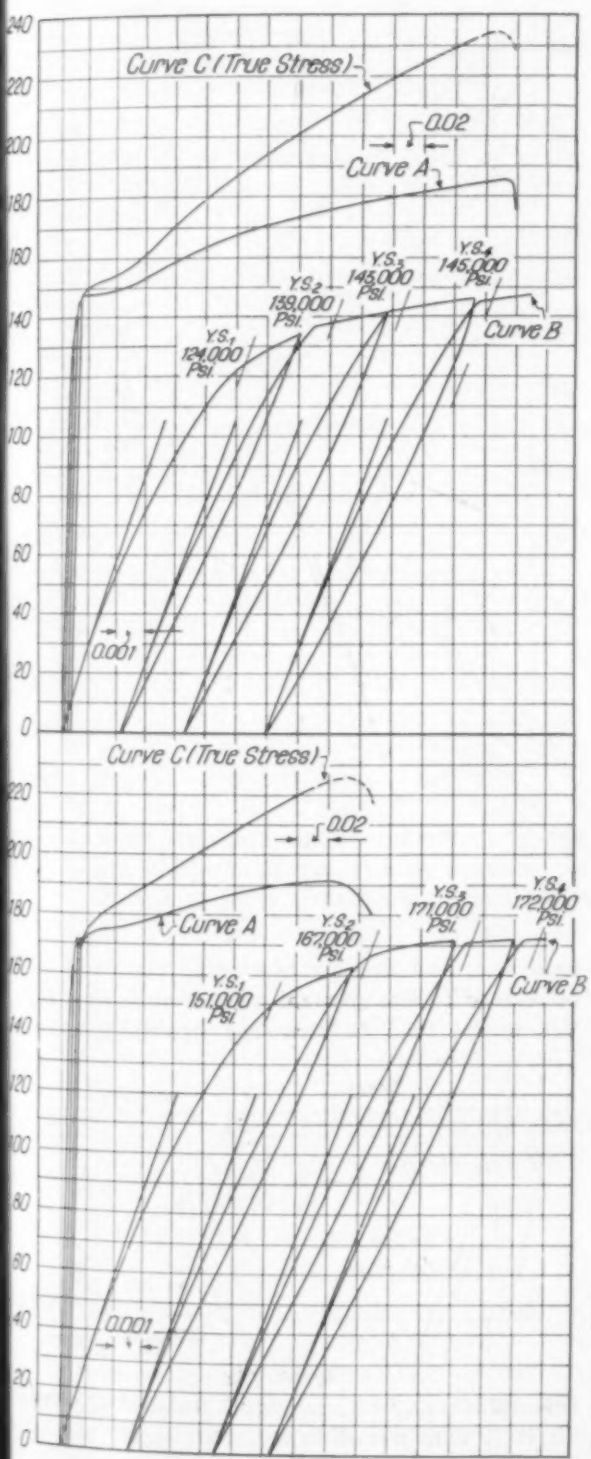



*Fig. 2 — Cyclic Stress-Strain Curves for 17-7, 0.035-In. Strip, Cold Rolled to 124,000 and 151,000 Psi. Yield Strength Respectively. Curves A and B are computed on original cross section of test piece; Curves C on sections uniformly reduced before necking occurs*

moments of the internal stresses around the neutral axis is zero. The other fibers are then at 1", 2", and 3", and the resulting strain values, $e_t$, $e_s$, and $e_r$ are as shown. These values are obtained from the true stress-strain data in a manner detailed at length in Brewer's and Schroeder's articles mentioned above.

Utility of such data to designers of sheet metal dies is shown in Shanley's article in *Journal*

## Use for Designing Bending Dies

The practical use of these curves depends upon a consideration of a bent metal part as shown in the sketch near the bottom of the column. This figure illustrates circular bending, characterized by a constant radius between the points of tangency. The total angle of bend under

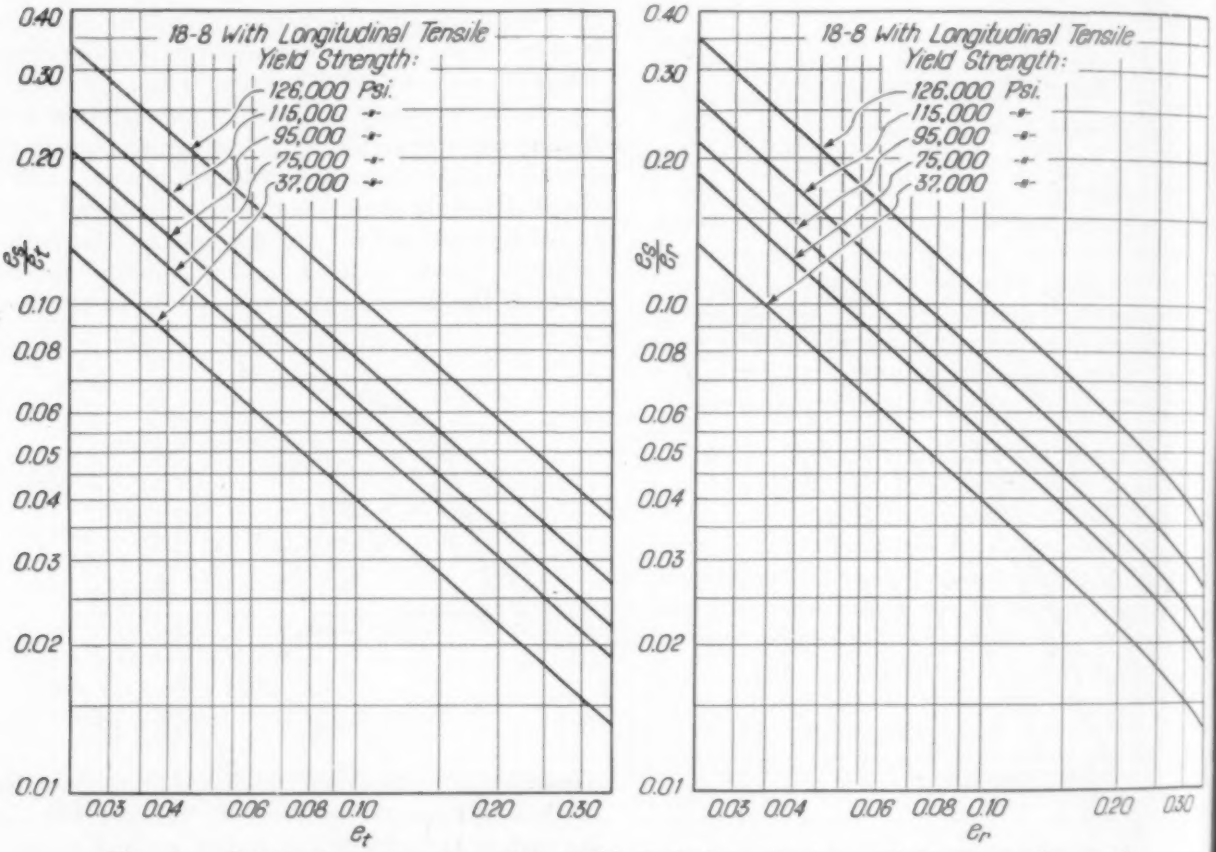
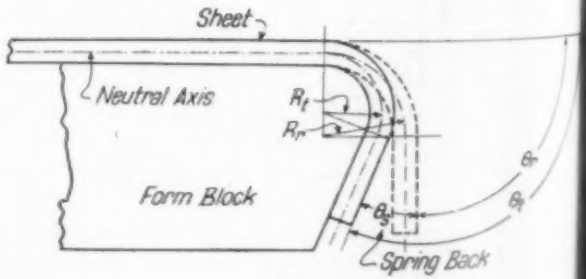



*Fig. 3 — Quotient Curves for 18-8, Cold Rolled to Various Yield Strengths, and Tested in Direction Longitudinal to Rolling. Curves to left are used when the curve on the die is known; curves to right when curve on finished bend is known*

of Aeronautical Sciences in July 1942. The quotients $e_s \div e_t$ and $e_s \div e_r$, derived from the true stress-strain curves of the types given in Fig. 1 and 2, are the most useful forms of the data obtained. These quotients for the 18-8 and 17-7 steels are shown in Fig. 3 and 4, plotted against $e_t$ and $e_r$ respectively. The data are represented by straight lines on log-log coordinates and the lines are designated according to the longitudinal tensile yield strength of the material. Besides the lines which represent the steels with yield strengths as shown in the cyclic stress-strain data, Fig. 1 and 2, lines are drawn for stainless steels with other yield strengths. The springback quotient for similar steels having intermediate yield strengths may be interpolated.

load is $\theta_t$ and the corresponding radius of bend, measured to the neutral axis of the piece, is $R_t$. When the load is removed, springback occurs




$\theta_t = \theta_r + \theta_s$

through an angle $\theta_s$, leaving a finished or residual angle $\theta_r$ with a radius $R_r$. This figure also indi-

cates the relationship $\theta_t = \theta_r + \theta_s$. By geometry the relationships

$$\frac{e_s}{e_t} = \frac{\theta_s}{\theta_t} \text{ and } \frac{e_s}{e_r} = \frac{\theta_s}{\theta_r}$$

are derived.

The quotient curves for $e_s \div e_t$ vs. $e_t$, at the left of Fig. 3 and 4, should be used in calculations where the allowable radius of bend or the die radius is known. The value of $e_t$ is computed from the relationship

$$e_t = \frac{T}{2R_t}$$

where $T$ = sheet thickness, in.

$R_t$ = die radius + ½ $T$, in.

and the corresponding value of $e_s \div e_t$ is found from the curves. The right hand curves in Fig. 3 and 4 representing $e_s \div e_r$ vs. $e_r$ should be used when the finished part radius is known. The value of $e_r$ can be found from the relationship

$$e_r = \frac{T}{2R_r}$$

where $T$ = sheet thickness, in.

$R_r$ = finished part radius, in.,

measured to neutral axis, and the corresponding value of $e_s \div e_r$ found from the curves.

It has been assumed in using these equations that the location of the neutral axis remains constant during deformation and is at one-half the thickness of the sheet. From a practical standpoint, this assumption has been found satisfactory even though there may be a shift of the neutral axis in accordance with curved beam formulae.

## Correction for Non-Circular Bends

In practice circular bending is not obtained and, as a consequence, certain parts of the bend will not be in exact conformity with the circular die radius. Hence, it is necessary to use a factor to correct for non-circular portions of the bend. This factor is influenced by the yield strength of the steel, the amount of strain caused by bending, and the pressure exerted by the press. It can be determined experimentally by making a series of constant radius bends through different angles and plotting the total angle of bend versus the springback angle. A typical curve obtained from such a test is shown in Fig. 5, on page 1080-D.

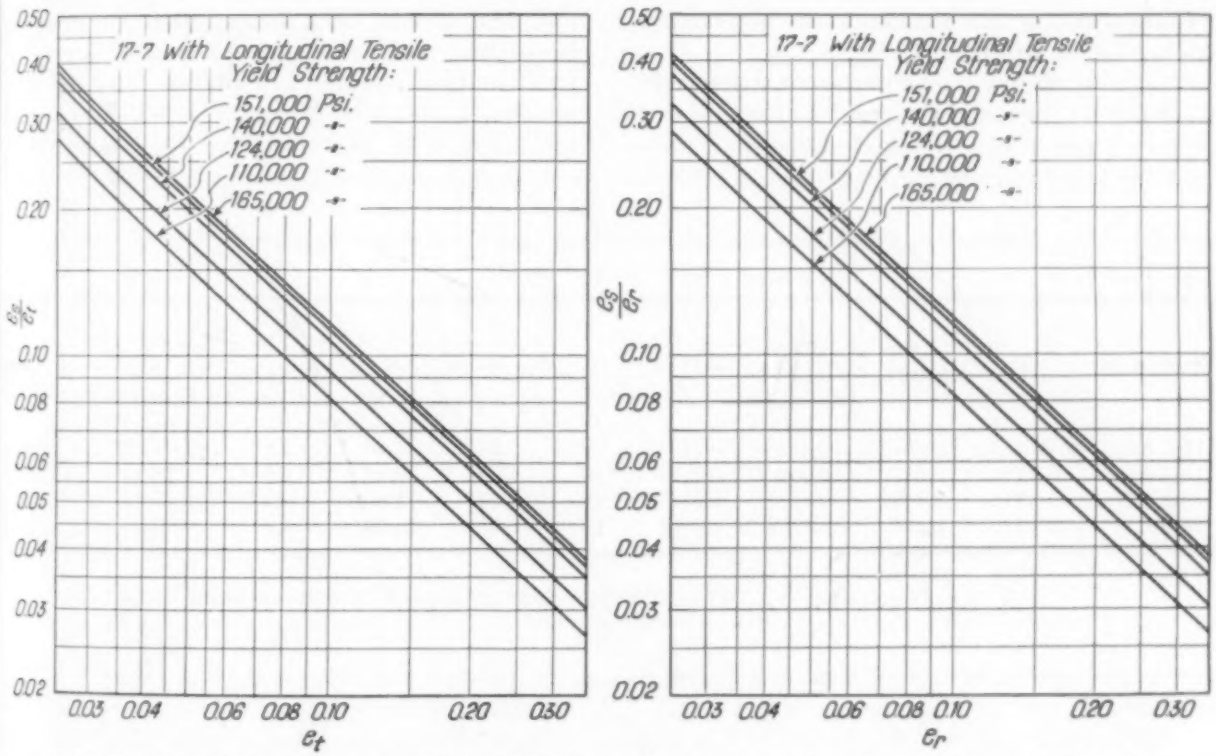



*Fig. 4 — Quotient Curves for 17-7, Cold Rolled to Various Yield Strengths, and Tested in Direction Longitudinal to Rolling. Curves to left are used when the curve on the die is known; curves to right are used when the curve on the finished bend is known*

It is observed that the experimental data fall along a straight line in accordance with the relationship

$$\frac{\theta_s}{\theta_t} = \frac{e_s}{e_t} = \text{K, a constant.}$$

It is also observed that the straight line does not pass through the origin of the plot, but intersects

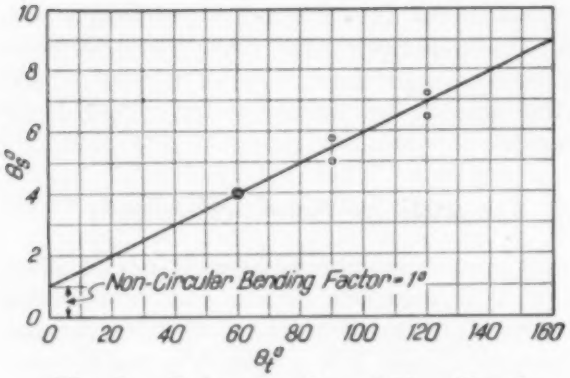



*Fig. 5 — Determination of Non-Circular Bending Factor by Extrapolation From Test Bends. Material: 18-8, annealed, 0.0315-in. sheet. Die radius: 0.1875 in.*

the $\theta_s$ ordinate at some distance from the origin. The magnitude of this distance is the non-circular bending factor in degrees.

Table V shows a comparison between predicted bend values and the results of actual tests made in a small, experimental rubber-pad press. The table also indicates the method of calculating values when using curves of the type shown in Fig. 3 and 4.

These tests prove the value of the data obtained for stainless steels from the cyclic stress-strain work. Agreement between calculated and observed bend values for these stainless steels is usually within 1 to 2°.

Angular springback increases with increase in yield strength, as is indicated in the springback quotient curves $e_s \div e_t$ in Fig. 3 and 4. To further illustrate the effect of yield strength on springback, a series of bend tests was made on 17-7 and 18-8 chromium-nickel steels having different yield strengths in tension in the longitudinal direction to rolling. Die radius was 0.625 in., die angle 90°, and strip thickness was 0.035 in. Results of the actual bends are shown in the table at the top of the next column.

**Springback, as it Varies With Tensile Yield**

| Yield Strength | Angular Springback |
|---|---|
| 36,000 psi. | 11° |
| 75,000 | 15 |
| 110,000 | 23 |
| 135,000 | 31 |
| 140,000 | 32 |
| 200,000 | 39 |

## Summary

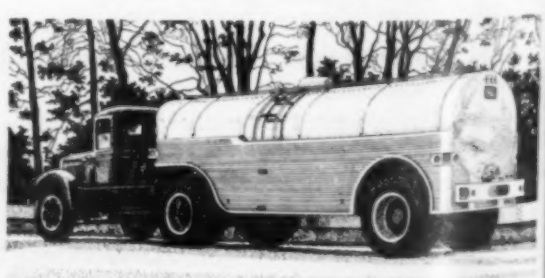
This paper contains a discussion of the mechanical properties of the annealed and cold rolled stainless steels of the 18-8 and 17-7 types. They have high tensile and fatigue strength, which make them especially suited for lightweight, high strength structures.

It is very often necessary to cold form them into parts, many being prepared by simple bending, and it has been shown that the bending properties of the steels are primarily determined by their true stress-strain curves. Log-log plots relating springback strain, residual strain, and total strain in bending have been derived for calculating bending problems. Springback quotient curves are presented for stainless steels of different yield strengths, inasmuch as the yield strength has an important effect on bending properties. Alignment charts have also been prepared and will be presented in a subsequent issue of *Metal Progress*. They will simplify the calculations. In the derivation of the springback quotient curves and the alignment curves circular bending has been assumed, and it is necessary to use a factor — as shown — to correct for non-circular parts of the bend.

**Table V — Computation of Bend Values and Verification by Experience**
(Notation as in text)

| Temper *(a)* | $T$ | Die Radius | $R_t$ (Die Radius + ½ T) | $e_t$ | $\theta_t$ | $\frac{e_s}{e_t}$ | $\theta_s$ | Non-Circular Bending Factor | $\theta_r$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Predicted | Actual |
| 18-8 An | 0.0315 in. | 0.1875 in. | 0.2033 | 0.0775 | 90° | 0.049 | 4.40 | 1.0° | 84.6° | 84.25° |
| 18-8 An | 0.0315 | 0.375 | 0.3908 | 0.0403 | 120 | 0.087 | 10.40 | 1.0 | 108.6 | 110.50 |
| 18-8 C.R. | 0.0315 | 0.1875 | 0.2033 | 0.0775 | 90 | 0.128 | 11.50 | 4.5 | 74.0 | 74.50 |
| 18-8 C.R. | 0.0315 | 0.375 | 0.3908 | 0.0403 | 60 | 0.250 | 15.00 | 4.0 | 41.0 | 43.0 |

Note *(a)* — An = Annealed, longitudinal.
C.R. = Cold rolled to 126,000 psi. tensile yield strength in longitudinal direction.



1944

# National Metal Congress

## (A Non-Technical Report)

by Edward C. McDowell, Jr.
New York City

THE BASIC STATISTICS of this year's National Metal Congress in Cleveland make it the largest one yet to be held. Some 50,000 people were involved one way or another in the proceedings. Five leading technical societies joined to present 163 papers in 50 technical sessions, in addition to six general meetings and 24 round-table discussions, to say nothing of innumerable breakfast, luncheon and dinner meetings and three formal banquets. More than 400 firms in the metal industries displayed their goods and services in the enormous Public Auditorium and its adjoining exhibit halls. On hand, too, were small but representative groups from England, Russia, China and Canada to observe and participate. The whole story of the Cleveland Congress is too big for any one person to be able to report it faithfully. The Editor of *Metal Progress* has confided to me that he has tried himself to report the Convention from a technical angle (think of it — 50 meetings, 163 papers) but has concluded that the whole activities of the cooperating societies and all their publications for a year constitute the *technical* report. This, therefore, has to be *non-technical*, so here goes:

MANY of the men and women who came to Cleveland the week of October 16 had no idea that they would do anything other than improve their minds at the various technical sessions or view their rivals' products in the exhibits. But their actual experience turned out to be more broadening than they had bargained for. Even the early birds like this reporter who arrived on the Sabbath of October 15th quickly perceived that the struggle for survival was going to preoccupy many a man who up till then had always assumed that Modern Science had solved his living problems.

The trouble was — as everybody who was there already knows — that when 35,000 out-of-towners try to squeeze into an already well-filled Cleveland, that fair city begins to split at the seams — a veritable case of municipal "Gaposis". Added to this out-of-town army were an estimated 15,000 inhabitants of the Cleveland area, many of whom had found it convenient to take hotel rooms for themselves during the week. As a result, the corporation presidents who had to sleep two in a bed could only console themselves with the fact that there was a war on, and the Waves, Wacs and assorted branches of the armed forces had long ago taken over several hotels bodily, and a metallurgist who had to sleep on a billiard table found that his bones were a very sensitive instrument for determining the Rockwell of the baize-covered slate on which he lay. (This is known as the Tibia Test and may open up a new field of hardness testing.) The overflow of humanity was eased somewhat by housing some 1200 men in the "Greater Detroit", a large lake steamer with excellent

# Ordnance
# Distinguished Service Award

*presented to*

## American Society for Metals

*In recognition of outstanding and meritorious engineering advisory services, in war and peace, for the development, manufacture and maintenance of Ordnance materiel.*

*Award Authorized 20 July 1944*

MAJOR GENERAL, U.S. ARMY
CHIEF OF ORDNANCE

MAJOR GENERAL, U.S. ARMY
CHIEF, RESEARCH AND DEVELOPMENT SERVICE

MAJOR GENERAL, U.S. ARMY
CHIEF, INDUSTRIAL SERVICE

BRIGADIER GENERAL, U.S. ARMY
CHIEF, FIELD SERVICE

BRIGADIER GENERAL, U.S. ARMY
CHIEF, MILITARY TRAINING SERVICE

acoustics, where they reposed in three-tiered bunks (and were served breakfast for a dollar). Countless others slept in private homes throughout Cleveland and its suburbs.

Food was not a problem in the restaurants, especially if you liked things such as liver and bacon or baked sweetbreads — which was all you could get if you were late — but there was no shortage of $5 planked steaks and other similarly priced items that look none too well on an expense account.

The really engrossing subject of the convention was NOT hardenability — although a handful of metal-lovers feigned an interest in it; the real interest was in cigarettes — where to get them. Probably the outstanding man at the Congress was the physicist who succeeded in trading his briefcase, with all its secrets intact, to a sailor in exchange for a half pack of Picayunes. Many a solid family man stayed away from the discussions in order to make sheep's eyes at the cigar-counter girls in a futile attempt to charm up some hidden Camels. So it went.

Naturally, when you confine 50,000 single-minded males in a strange city, drinking is going to be a problem, and it is a fact that some of the younger Doctors of Science sometimes allowed themselves to sip an after-dinner cordial — indeed, sometimes two of them. Nor would it be surprising if there weren't some secret drinking of light wines in the hotel rooms. Candor requires me to report a remark my friend the bartender at the Hollenden Hotel made on Thursday: "Brother, will I be glad when them monkeys go home — I'm going nuts!"

JUST WALKING AROUND the hotel lobbies and the Auditorium and listening to the talk, a layman — such as this writer — could easily get the impression that the most important thing in the lives of the assembled metallists was metal. Actually, it's not. Once you penetrated the metallic outer covering of the people at the Congress it became apparent that metallurgists are just like human beings. One solemn-looking individual — L. E. Cyrtmus of the Wheeler Instrument Co. — told me that when the Congress was over he was going up to Northern Wisconsin to hunt bear with a bow and arrow. Said that it is easier to bring down a running deer at 200 ft. with an arrow than with a bullet. (I know, I know, but that's what he said!) And you would think that Walter Jominy, having won the Society's highest technical honor — the Sauveur Achievement Medal — would just *have* to like metallurgy, but it's probably just a convincing pose. Actually, he is a flower-lover — mostly roses — and likes best to grub about in his garden like the fellow in the illustrations of the retirement-annuity advertisements. Even ASM's president, Kent Van Horn, watches the clock at the Aluminum Co. and rushes away at 5 P.M. for an early dinner so that he can spend the evening arguing the merits of Mozart and Beethoven with this magazine's editor, Ernest Thum, who prefers the moderns such as Debussy or Sibelius. Imagine that! Have neither of them heard of Bach? [EDITOR'S REJOINDER — Countless were the hours spent at the ancestral upright piano struggling with the Three-Part Inventions.]

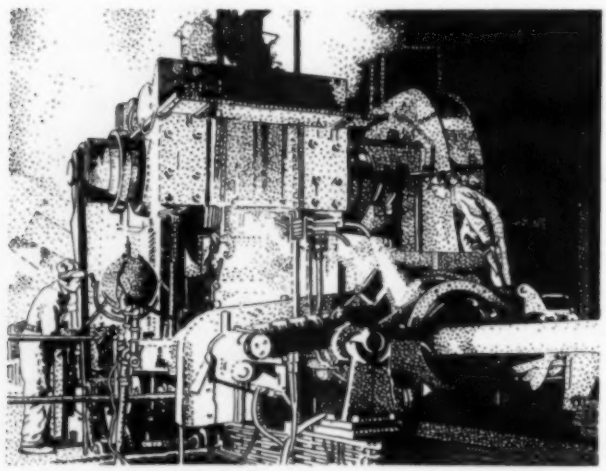
DOWN AT THE AUDITORIUM, however, you didn't see much of the soulful side of metallurgy, which is perhaps just as well. The clamor and the tumult of the 400 exhibits and the formal monotone of the technical meetings both gave the same strong impression of the seriousness of the work at hand and the urgency of the war effort under which all of industry's energy and skill have been united. This pooling of skills and energies, both with industry and with the services, was remarked upon repeatedly by Captain T. A. Solberg, the Navy's head of research in the Bureau of Ships, in his address at the first Victory Session on Monday noon. He said that it was of the utmost importance that this cooperation and general pooling of information be maintained after the war. And he concluded his address with this challenging question: "Can we pour these same energies which are bringing us victory in war, down constructive channels with undiminished intensity, to build in the future an even stronger greater nation?"

The basic theme of this year's Congress was "Design for Tomorrow" and it was apparent, indeed, that "after the war" was on 'most everyone's mind, although it was generally unexpressed or played down in deference to the present responsibilities to the war effort. But the nature of many of the exhibits and the general preoccupation with techniques and processes suitable to the peacetime arts was evident to any visitor, and many of them commented upon it. It is interesting in this connection to note that the Los Angeles Chamber of Commerce and the State of Washington were both represented at the show by active committees and attractive exhibits, anxious to sell the Eastern industrialists on the merits of the West Coast as a region of fastest future progress when the war closes. (The Cleveland Chamber of Commerce also had an attractively furnished space, designed to offset the efforts of the Westerners. Well, we still have a competitive economy!)

THE EXHIBITS themselves were interesting and, on the whole, well-prepared. Color is coming back — I was told that the 1942 and 1943 exhibitions were rather drab affairs. Exhibitors varied widely in the manner in which they presented their wares; some of them were undemonstrative and static, and content to let you mosey around and ask questions if you felt like it; others were busy as bird dogs, talking up their products untiringly to any and all visitors regardless of whether they were purchasing agents or mere metallurgists.

It would have been a good thing for some of the exhibitors to have climbed the steps to the deserted balcony seats in the arena and looked down at the floor from there. From that height, with the whole floor spread out below, it was immediately apparent that most of the visitors were stopping and crowding before the booths where there was movement and noise, whether it was caused by a machine being demonstrated or merely by some decorative gadget moving up and down to catch the eye.

On the whole, it seemed that the machines — especially those that went "Bang!" and gave off satisfactory sparks and flashes — were the star attractions, although it is probable that many of those so attracted were merely curious and



were not significant visitors from the exhibitor's standpoint. It is hard to make a selection without slighting dozens of meritorious displays. For what it is worth, this unpracticed eye found notable among the exhibits the presses of the Kux Machine Co. which turned out a steady stream of small objects compressed from metal powders; the die-casting and injection molding machines of Lester-Phoenix, Inc., which produced plastic cigarette containers which this writer and many other visitors carried away as souvenirs; the Nelson Specialty Welding Equipment Corp's. spectacular demonstration, brought all the way from the West Coast, of welding studs to a steel plate, and the unsuccessful efforts of strong boys from the audience to break them off with a hand sledge. That exhibit had everything — sparks, flashes, smoke, red-hot metal, and finally the satisfying noisy sledging on a steel plate!

Eastman Kodak Co.'s exhibit contained two "stoppers" for any photographic enthusiast. One was an aerial photograph taken on continuous-strip color film from a height of 350 ft. in a plane going 350 miles an hour. The film was about 20 in. wide and reveals the amazing advance that has come in photographic equipment for this purpose during the war. The other item was a large X-ray plate of a casting, and its caption read, mysteriously: "Restrictions prohibit revealing the source of this interesting radiograph. It represents a most advanced technique." Coyness like that could make a man crazy if he was really interested in radiographs of castings.

To this layman's mind, one of the most effective jobs in the show was done by Dow Chemical Co. — especially in view of the fact that magnesium is not as attractive a metal as, say, copper and brass, and doesn't lend itself to interesting demonstrations. The Dow people overcame this handicap nicely, however, by having lots of things for visitors to play with, in the course of which the visitor found himself forced to notice how light magnesium is, how it compares with other metals, and what you can use the stuff for. It was painless. You could even stamp out a coin for yourself (of magnesium, of course) by pushing a button. The prize "come-on" was a beautiful model — a magnesium blonde — whose weight you could guess, and which provided this reporter the only legitimate excuse he has ever had to walk around a good-looking girl and frankly ogle her charms — a necessary operation, of course, in estimating her weight, and undertaken strictly in the interests of gravitational science. The trick here was that the visitor also had to lift an iron casting and a magnesium casting and give the aggregate weight of model, steel and magnesium in order to win the War Bond prize offered. I carried away the one impression that I'm sure the Dow people wanted me to retain, to wit: "That certainly was a pretty girl". P.S.: The bond also went to someone else.

Other exhibits that seemed to get a lot of attention included the Magnaflux inspection demonstration; the DuPont demonstration of the continuous electrotinning of copper wire at what seemed a mile a minute; the shot-peening equipment of the several firms in that field; the Tocco induction heat treating demonstrations — in fact,

the surprising number of firms in this miraculous field; all of the die casting exhibits; and the new low temperature "cold treating" exhibits.

Some people at the Congress complained that the exposition was too big, and maybe it was for a few, but it seems likely that most of the visitors saw everything they had their hearts set on seeing — and lots besides.

ONE of the best-done jobs at the Congress was the organization of the technical meetings and panel discussions. (I can speak with authority on this, for it represents a technique I have attempted to attain myself.) The fact that these meetings were so obviously appreciated by everyone is a tribute not only to the men who labored so hard to prepare the papers but also to the careful planning and organizational work which mapped and timed each meeting and saw that it went smoothly. Each morning at 8 A.M. the chairmen and summarizers or technical contributors of that day's ⊜ sessions met at breakfast with staff members and were briefed as carefully on their targets as any bomber crew. Doubtless much of the planning and organizing for these sessions began weeks and months before the Congress met.

Another excellent and valuable feature of the Congress was the series of Victory Sessions at noon each day, at which addresses were given by prominent men from industry and the technical branches of the Army and Navy. The addresses of Captain Solberg of the Navy and of Walter S. Tower, president of the American Iron & Steel Institute, were especially fine.

It would be nice if I could here give an accurate picture of the technical and other activities of the societies that cooperated with the ⊜ in this supercharged week, but candor forces the admission that it would merely be cribbed from the printed program. Each man to his own meat, or in other words, there was ample and varied intellectual fare for all who were energetic and bright enough to absorb it — even the danger of mental indigestion for the uncautious.

The annual banquet of the ⊜ went off as smoothly as all its other activities and was an enjoyable evening for the more than one thousand members present, and a memorable occasion for the several men to whom awards and honors were conferred in recognition of their services to metallurgy. These men, all of whom rose and accepted their honors with appropriate grace and humility, were Walter E. Jominy, the Sauveur Achievement Medalist; R. C. Stanley, recipient of the ⊜ Medal for the Advancement of Research; G. R. Fitterer, who delivered this year's Campbell Memorial Lecture; and Messrs. R. A. Flinn, Earnshaw Cook, and J. A. Fellows who were jointly awarded the Howe Medal. Available for inspection, too, was the U. S. Army Ordnance's Distinguished Service Award, presented to the American Society for Metals during the week, the presentation being made by Maj. Gen. G. M. Barnes, chief of Ordnance's technical division.

IN CONCLUSION, it may be interesting to compare this year's exposition with those preceding it, as reported by some of those who have helped mount these shows, year after year. Everyone was impressed by the monumental proportions of the Cleveland Public Auditorium and with the obviously great physical problems involved in moving in all the exhibits and setting them up. There were many headaches. This year's 406 exhibitors were approximately twice the number of those at either of the last two Congresses and, all told, they brought with them more than 500 major pieces of equipment to put on display. Many of the exhibits arrived only a day or two before the exposition opened, and for a while there simply weren't enough workmen, electricians, and other help to take care of everyone at once. After the show opened, six additional firms decided that they wanted to enter exhibits, one of them taking space on Thursday — the next to the last day of the show. More than 40 miles of electric cable were used just to connect the various exhibits with the Auditorium's power supply.

The cost of the decorative backgrounds for the displays alone is estimated at about $200,000 and it is thought that the average cost per exhibit ran around $3000 for the week — a total of about $1,500,000. If we add to this the amount spent by the visitors on rail fare, hotels, food — but let's not. Whatever the total, it was spent on a constructive and worthwhile project. It is interesting to note that on one day of that same week a record high of about $3,500,000 was wagered on the ponies at Belmont Park — a fact which makes the cost of the National Metal Congress seem very, very conservative. ⊜

# Acid Electric Furnaces and Steel (Foundry Problems)

Report of the Second
**Electric Furnace Steel Conference**
A. I. M. M. E.
Pittsburgh, Pa.

SPONSORED by the Electric Furnace Steel Committee of the Iron and Steel Division, American Institute of Mining & Metallurgical Engineers, the second annual electric furnace steel conference was held in Pittsburgh on October 5 and 6. Registration of over 600 was 25% higher than the previous conference. The first day was occupied by a discussion of problems met jointly by acid and basic furnaces, such as mechanical and electrical equipment and refractories. On the second day, separate sessions were held, one on operation of acid furnaces, the other on basic. The following notes will be confined to the former topic.

## Silica Roof Refractories

Much discussion centered on the problems of roof construction and maintenance. Even after discounting the figures for average life (furnace operators are human, and are as prone to pick out their best figures for the "records" as are fishermen or automobile travellers) a very large increase in roof life with its corresponding reduction in refractory costs and increase in furnace tonnage will follow the intelligent application of a few precautionary measures. They may be briefed as follows:

**Take Care of the Brick** — Bruised corners — anything that interferes with perfect fits — are centers of rapid deterioration. Handle brick as little as possible; some manufacturers ship them on pallets and they can be moved from car to storage to furnace by lift-truck. Another good way is to move the right number of bricks or blocks for a complete roof or ring by crane in an iron boat. *Forbid* masons hammering bricks in place, or using "slivers" rather than splits; half-sized brick should be the minimum. Storage should be in the dry, especially in winter time when frost gets in its dirty work.

**Build a Good Arch** — A substantial center or form (even a solid concrete dome) is a great help. The roof ring should be a little larger in outside diameter than the shell, for proper support on a wasted wall. The metal ring should be true to shape — unwarped. The skewback course is of particular importance and should be thoroughly packed with ganister between brick and ring. Expansion joints in the form of tar paper or wood shims should be inserted between courses and no further apart than 12 in. around the ring. Use as much expansion as possible without incurring slippage and spalling — a maximum which depends on diameter of roof and size of roof blocks, and can be found by trial and error. Proper clearance at electrodes and adequate coolers at electrode openings are also essential if rapid failure there is to be avoided.

**Dry and Preheat the Roof** — A 30% gain in life was reported after adopting the plan of stacking three or four roofs on a steam jacketed steel slab and letting the hot air work its way up, eventually warming the brick to the touch. At a west coast plant with 40-ton furnaces and 15-ft. roofs, life was increased from 25 heats to 100 heats, four fold, by numerous improvements, one of which was the preheating of roofs in an electric oven, taking 60 hr. to reach 1000° F. Said another: "A slow first heat will reduce spalling and fractures in the roof, and we'll all come back to it when our prime object is no longer to make

eel rather than to save brick." In any event, pid temperature changes *below* a red heat ould by all means be avoided, for this is where e damaging volume changes occur during crys- llographic transformations in the silica.

**Keep the Roof Clean** — Startling statements re made that dust settling on the roof will cut e life by one-third. Best practice is to work a tle sillimanite slurry over the top after the st heat, and then blow off the dust after every ift — certainly once a day.

**Favor the Roof a Bit** — Silica roofs cost oney, and while they are built to be used, the st economy will spend a little on steel making nvenience if a little more can be saved in fractory costs and shutdown and repair time. e most enduring roofs are those on small fur- ces that are relatively high; the low sidewalls the big furnaces bring the spring of the arch se down to the hot bath and heat-scour is rela- ely rapid. Generally speaking, light scrap on of the cold charge shields the roof from direct flection during melt down. By the same token, quick penetration of the electrodes into the cold arge will help. Violent boils splatter and flux e roof with iron oxide — avoid them; if the oper amount of ore is charged, then re-oreing unnecessary, and this saves labor and roof ick as well. Use power from the high tap the minimum time. In basic practice, at reflected from the strong carbide slag is rticularly damaging. Temperature fluctuations ould also be avoided; if the roof swings aside r charging, do the job promptly, without delay. nce duplexing incurs less violent temperature anges in the furnace, roof life is better on rnaces receiving hot metal, other conditions ing the same.

## New Types of Roof

Electric furnace roofs have been designed d constructed of basic brick suspended from overhead grillage of beams. They apparently ve enough promise to warrant further develop- ent. The real news is about a roof used by the thlehem Steel Co. on a 50-ton furnace installed 1940 in a 60-year old building having a low, ort craneway. Extra handling, due to the space itations, mounted up so much that it takes hr. to replace a roof. Silica roofs averaged 43 ats, and in an effort to save some down-time e metallurgists turned to sillimanite brick (65% $Al_2O_3$). This refractory resists iron oxide at least % better than "super-duty" silica brick, and e sillimanite roofs average 133 heats. Their use erefore saves 8 hr. in down-time during their life. Another distinct advantage is that the arch starts sagging slowly when it burns down too thin, but hangs on until the end; none so far has caved in.

## Rapid Carbon Estimation

A complete session of the Acid Steel Group was devoted to rapid control methods, and interest centered almost exclusively on carbon estimation, since most foundrymen present were making comparatively little alloy steel. *Time* for such tests must be short because heats move rapidly in a steel foundry — a boil of say 12 min. and no more than 80 min. tap to tap, in rapid work. Four principal methods for carbon are in use, namely by fracture, by chemical analysis, by magnetic flux, and by hardness. Notes on each of these will be presented:

**Carbon Test by Fracture,** the traditional method for low carbons, no alloy. It was pointed out that both carbon and silicon can be estimated by fracture tests during the working of a heat, since silicon is judged by the top appearance of the small test ingot and its shrinkage (even to an actual split or cavity between top and bottom part). Usually the melter does not break test bars whose tops have a bad appearance. Likewise he watches the amount of sparking during the pouring of the test. During a vigorous boil, metal analyzing 0.18% Si and 0.22% C will have few sparks; on oreing down to 0.10% Si and 0.18% C the sparking starts; on "go-ahead" (0.03% Si and 0.12% C) the sparks thrown off are voluminous. The expert melter also estimates carbon content not only by the grain size, but by the orientation, whether random or columnar. Description — even illustration — is so difficult that the beginner would be off 15 to 20 points in his estimate; the best accuracy would be had from an old-timer who has watched the progress of the heat, and he can come within a 5-point range in 19 out of 20 cases. Time for making the test is 3 min. or a little less.

**Carbon by Chemical Analysis** — It is recognized that combustion trains are most accurate; consequently many successful efforts have been made to speed up the manipulations. Determinations to within 0.005% may be made in 10 to 12 min., 5 min. of which are used up in "burning time"; it takes that long to be sure the sample is *entirely* oxidized. Accuracy of 0.01% may be had by reducing burning time to 3 min. It takes 1 min. to drill and weigh the sample, another minute to weigh the absorber and report, so 5 min. is about as fast as a chemist can work. Such speed is only had if he has an automatic

balance, magnetically controlled, that reads from a dial like a Toledo scale. Usually 6 or 7 min. would be good time for a combustion carbon — sample spoon to report, and that's hardly fast enough for a rapidly working acid furnace..... A beautiful set of equipment for volumetric estimation of the evolved $CO_2$ was exhibited. In this ready-made device the volume of $CO_2$ plus excess combustion oxygen coming from the train is measured, then the $CO_2$ absorbed in a KOH tower, the volume of remaining oxygen re-read, and $CO_2$ is had by difference. It is said that this volumetric method is more reliable than a conventional gravimetric train in the hands of inexperienced help; accuracy is nearly as good, and speed likely to be a little better.

**Carbometer and Carbanalyzer** — While there are five magnetic properties that vary with a steel's composition, permeability is measured by all the commercial equipments, probably because there are the least interferences and the variation is fairly marked over the range of carbons likely to be encountered. Requirements of simplicity in sampling and routine, of accuracy and rugged construction are met in two well known machines, the Carbometer and the Carbanalyzer. The first is the pioneer, of Swedish manufacture, and costly (about $3000). It is therefore limited to a few of the older, larger shops. It is rugged and accurate, and the men like it for it has a self contained power generator that automatically operates from a clock spring drive. The American-made Carbanalyzer was introduced about five years ago. It is more portable, weighing about 32 lb.; it operates from battery current and requires a routine of switching operations and periodic adjustment. (A third device known as the Leitz-Blosjo machine, compares the permeability of the test sample against that of a standard bar.) For accuracy and reproducibility in any of these machines it is necessary that the sample must be correctly cast in standardized routine; slag, porosity, chilling, residual alloy content, surface condition — all affect the results. However with reasonable constancy in these matters the resultant accuracy is within $\pm 0.03\%$, considerably better than any but the very best of fracture tests. Likewise it is very fast, 2 to 3 min. from spoon to analysis. Use of such devices will reduce the number of heats that are off-chemistry, one speaker saying that they fall within a much narrower range on either side of the mean. Aiming at 0.25% C in the finished castings the minimum in 1500 heats was 0.19% and the maximum 0.30, and the *number* between 0.22 and 0.28 is much larger than when relying on fracture (plus a combustion carbon now and then).

**Carbon by Hardness Test** — Some kind wor were spoken for the Rockwell hardness tester a carbon estimater. It is well known that ord nary alloy content does not affect the maximu hardness in a fully quenched steel — *that* is pr marily a function of the carbon. The trick is get a sound flat sample, completely hardened martensite. (Foundrymen may find it very hel ful to add a measured amount of aluminum the spoon before casting the test piece, a stu that openhearth men use to insure a sound bar Success has been had in a ⅜-in. square mold graphite, the sample quenched cherry red in cold water, a spot ground flat, tested for har ness, and carbon taken from the calibrati curve. Some doubts are held as to the ability keep the testing machine in shape when expos to the rugged life in the melt shop. One speak thought that an accuracy of $\pm 0.02\%$ could achieved — on the same order and at the sa speed as the magnetic machines, and much bet when the latter are influenced by unsuspect tramp alloys in the test piece.

## Gas in Steel Castings

As if the ordinary troubles that beset a m trying to turn an honest penny were not enou steel foundrymen have to worry about dissolv gases in their metal, ready for casting. Pin h porosity has been with them ever since steel ca ings were made, but in the old days it could explained to the equally ignorant purchaser "an appearance inherent in *steel* castings, indi tive of otherwise excellent quality". Now-a-da much effort is expended in eliminating the defe hydrogen gas is supposedly the culprit, and most potent source ascribed to wet ladles. Oth say one must dry the molds, but still anot finds no change in the castings when moisture the mold rises from 1% to 7%. Hydrogen well as nitrogen and oxygen) is swept out metal during the boil, presumably by a mecha ical action, but gas is apparently reabsorb when the metal is quiet. One speaker ventur the opinion that acid electric steel always ha threshold amount of hydrogen, and even tiniest pick-up will then give trouble, or mak "sensitive" steel. Ferro-alloys contain a consid able and variable amount of hydrogen; elect lytic nickel particularly is so loaded with it th it should be annealed before putting into "sen tive" heats. This reporter would suspect th much talk about gas in steel castings is ba either on guess work or wishful thinking, for simple reason that accurate gas analyses are easy to make — in fact are seldom made.

reinforce this suspicion he heard — during the discussion of "flakes" which apparently have left the big forge shops and invaded steel foundries to infect even small castings — that a lot of experimentation was going on based on the belief that the amount of hydrogen in the steel could be estimated by its flakiness. (Maybe so, but I would as soon try to correlate flakes with, say, radio static or the melter's rate of alcohol elimination at the time of cast.) It is also noteworthy that there is little conversation about nitrogen in steel castings from acid electric furnaces, yet there's plenty of nitrogen there. Whereas 0.003% would be expected in an openhearth steel, 0.008 is the low limit in electric steel, and the latter frequently goes up to 0.015% (the equivalent of nitrogen in bessemer steel).

### Graphitization of Valve Castings

A disturbing situation has arisen from the discovery of graphitized zones in high temperature steam lines in both carbon-molybdenum steel castings and tubing. In a zone just outside the joint, where the original material was superheated during welding and cooled rapidly with induced internal stress, a plate-like graphite precipitates. A similar condition can be induced in the laboratory by heating to 1050° F. for 500 hr. in the most susceptible cases, although 3000 hr. is more usual — at least in steels that have had some aluminum added in the ladle. Studies on the graphitization of 1% toolsteels, conducted by Prof. Charles R. Austin and his associates at Penn State College, indicate that dispersed aluminum oxide (which may be formed even by "internal oxidation" during heating or heat treatment) will accelerate if not induce this action, and it has therefore been suggested by important users of high temperature equipment that the use of aluminum as a finishing reagent be prohibited in the foundry and steel mills. This would impose an almost prohibitive situation on the steel foundries, for aluminum is the prime reagent for controlling porosity, and the counter proposal is being made that enough chromium be added to the alloy to "stabilize" the carbides, even in the presence of the usual aluminum required in commercial steel foundry practice. An added difficulty lies in the fact that aluminum is generally believed to induce fine grain in steel, whereas coarse grained castings have better creep strength. It results that the foundries catering to the valve, power and chemical industries will have difficulty in furnishing sound castings that are at the same time coarse grained and free from the urge to graphitize.

# Furnaces for Salt Baths

**By Leon D. Slade**
Superintendent,
Gleason Works
Rochester, N. Y.

MY TASK is to "summarize" the information presented this afternoon at the Group Meeting discussing Salt Baths [National Convention, Cleveland, Oct. 19]. After listening to these six men speak on the several phases of the subject assigned to them it would be presumptuous for me to try to elaborate on or to improve their remarks. However, since at the present time there are so many different *salt baths* and on the other hand such a variety of *furnaces*, each of which is dependent on the other for its success, it might be well at this time to introduce them to each other.

In the time allowed me it would not be possible to go into detail, but any one viewing salt baths in a general way, that might be of use to a present or prospective user, it would certainly be well to include a consideration of furnaces (which topic was omitted from the formal program this afternoon).

A few years ago, nearly all salt bath furnaces were made with a metal container for the salts, this container being put into a furnace setting and made of iron, chromium-iron, nickel-chromium, or similar heat resisting alloys. Later, ceramic pots were used for the high temperature baths, but because of breakage and constructional troubles the trend is now to a built-up brick container, with walls thick enough that any liquid salt penetrating a crack or joint will freeze before reaching the outside. Such baths are heated, obviously, by internal means.

This construction has solved many problems connected with high heat furnaces, but there is considerable question as to where the utility of this type leaves off and that of the metal container comes in. Factors such as size of bath, type of salt, and temperature of freezing should be talked over with the builder of the equipment before coming to a decision.

Immersion electrodes for leading in the current to heat the baths are usually either in a fixed position or of adjustable construction. Either has its advantages. The distance apart and the conductivity of the salt used at different temperatures has a bearing on the size and voltages of the transformers required.

## Transformer Requirements

A transformer for a fixed electrode furnace which is not used continuously but is held at a reduced or holding temperature part of the time should have a tap that will give a voltage of about 60% of the transformer rating, to maintain the salt at or near the freezing point during the stand-by period. Another tap should have a voltage that, at the operating temperature of the bath, will furnish 100% of the transformer rating. The holding tap should have a voltage that will allow the bath to freeze over on top but high enough to take care of the heat loss from the walls so that it cannot freeze solid. With a salt of low melting point it would ordinarily be more economical to leave the control on at all times and not allow the salt to freeze. A good furnace setting will radiate heat so slowly that it will take a long time for radiation to equal the power required to thaw out a frozen mass of salt.

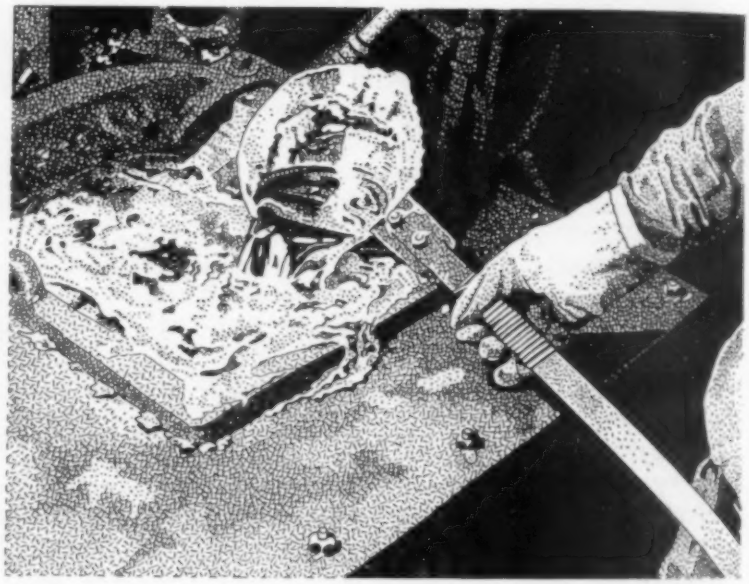
These are the three main taps; any others would be installed to suit the operating conditions of the particular furnace. Of course a furnace having adjustable electrodes does not require the addition of such special transformers for its operation.

The ordinary pyrometer will control most of the baths close enough for ordinary purposes. However, a high heat bath for hardening high speed steel requires very close control as there are certain variations in the thermocouple, instrument swing, and external resistances that may cause trouble, particularly with the high speed steels containing considerable molybdenum. There are several ways of meeting this condition and any furnace builder can supply the one that is best for his furnace.

There have been such rapid advances in the use of salt bath furnaces in the last few years and so many good companies are furnishing baths for such a variety of purposes that the only practicable method of selection is to pick out a good furnace and bath today and hope that it will not be changed before you receive the equipment! As already indicated, the installation which calls for the most thought and consideration in its selection is for furnaces and baths for the hardening of high speed steel.

Today, the majority of high heat baths use anhydrous barium chloride treated in various ways and used with a suitable inhibitor to eliminate decarburization of the steel resulting in "soft skin".

Where the tools are to be ground all over after hardening, the pure barium chloride may be used in the high heat, coupled with a preheat bath which will not contaminate the high heat readily. If a similar bath is used for the quench there is no danger of contaminating one bath with another from drag-out by hangers, pokers or sludge bars.



If a cyanide mixture is used for a quenching bath, great care should be taken to prevent any carry-over to the other baths.

The soft skin condition on tools that are not ground all over after hardening requires constant attention, as decarburization may be so deep that a cyanide quench will not correct it.

To take a quick look ahead, I foresee the increasing use of conveyorized salt bath units, a great improvement in transformer design utilizing modern electronic controls, the development of a low-temperature drawing bath for high speed steel which would not oxidize or otherwise affect the surfaces of the tools or contaminate the other baths in the cycle, and, finally, the continuing development of all phases of salt bath hardening to the ultimate end of better quality of product at lower cost.

# Notes on Synthetic Rubber and the Necessary Equipment

by Myron Weiss
New York City

*So much interest was exhibited in the recent article in Metal Progress on Jet Propulsion — although there was little that could be said about the high-temperature metals required — that The Editor is encouraged to present some other articles of similar nature. This one on synthetic rubber is even more sketchy in its direct news about the metals involved, but the effort is to present not so much a discussion of metals which will not contaminate or "poison" a chemical reaction, as to give members of the ⊜ an understandable and brief account of some of the important associated war efforts that would be impossible without a generous supply of proper metals for the manufacturing equipment.*

GOODYEAR Tire & Rubber Co. has just perfected a continuous process for the manufacture of synthetic rubber. Hitherto the $200,000,000 of U. S. synthetic rubber establishments have been producing by batch polymerization. The continuous process, says Goodyear's R. P. Dinsmore, vice president in charge of research and development, will add 400,000 long tons to our production. This would bring capacity up to 1,338,000 long tons yearly.

This promises to make the United States practically independent of natural rubber, if we wish it so, and poses a difficult problem of livelihood to the 2,000,000 people of the East Indies who before this war cultivated 9,000,000 acres of rubber plantations. It also poses new problems to the Ford rubber cultivators in Brazil and the Firestone people in Liberia. American industrialists may be expected to look out for themselves; the future of the market for natural rubber in this, the country of largest consumption, depends on three main factors — *(a)* the desire of friendly nations to reverse lend-lease by shipping us the natural gum, *(b)* the production cost of artificial rubber-like substances and *(c)* the relative durability of the two classes of materials in the item of largest demand, namely tires.

The price of synthetic rubber has not yet reached its least common denominator. It probably will never fluctuate as has the price of natural rubber, which reached $3.00 a pound in 1910 when the Model T was popular; the low of 15¢ a pound in the post-war depression of 1922; the artificial high of $1.20 a pound of 1925 when the British and Dutch plantation controllers put their restriction plan into effect; or the low of 3¢ a pound of 1933 when the natives of the Netherlands East Indies tapped their own trees and sold the latex for whatever they could get.

**Metals** in tremendous quantities are used in this new chemical industry for storage, piping and pumping the raw materials and reagents — mostly liquids. Metallurgical ingenuity has held the use of chromium and nickel alloys to the minimum, and has solved many a processing method without the use of strategic materials that would doubtless have been used had they been readily available. Further on some of the metallurgical problems will be mentioned, with brief notes as to how they were met.

## Five Synthetic Rubbers

*Natural* rubber is a polymer* of a hydrocarbon called isoprene ($C_5H_8$). Most *synthetic* rubbers are co-polymers* of two or more ingredients mixed in such proportions as to cause them to react and give the product the desired characteristics. Natural rubber surpasses synthetics in most performances, or resistance to physical conditions. On the other hand, synthetics surpass natural rubber in resistance to most corroding influences that cause chemical deterioration.

Five main types of synthetic rubber dominate the field. They are: Buna-S, Buna-N, Neoprene, Butyl and Thiokol. The accompanying table, presented by courtesy of U. S. Rubber Co., displays their comparative properties.

**Buna-S** is a co-polymer of butadiene, $C_4H_6$, and styrene, $C_2H_3(C_6H_5)$. The term comes from the *Bu* of butadiene, the *na* of natrium (sodium), and the *S* of styrene. (Sodium was originally used as the polymerizing catalyst.) The chief U. S. manufacturers of Buna-S are United States Rubber, Firestone, Goodrich and Goodyear. [illegible] seems to be the best synthetic for tires. To bri[illegible] out its best properties it requires compoundi[illegible] with carbon black; therefore all Buna-S produc[illegible] are going to be black.

**Buna-N** is a co-polymer of butadiene a[illegible] acrylonitrile ($C_2H_3CN$), which is also called viny[illegible] cyanide. The *N* refers to the nitrile or cyani[illegible] radical. Belonging to this type are **perbuna** made by Standard Oil of N. J. and Firesto[illegible] **hycar** made by Hycar Chemical Co. which Phill[illegible] Petroleum and Goodrich own; **chemigum** ma[illegible] by Goodyear; **thiokol RD** made for the Thiok[illegible] Corp. by Dow Chemical and not to be confus[illegible] with the thiokols reported below.

**Neoprene** is a polymer of chloroprene, $C_4H_5C$[illegible] developed by Du Pont.

**Butyl** is a co-polymer of isobutylene, $C_4H$[illegible] and small amounts of other unsaturated hydr[illegible] carbons such as butadiene and isoprene.

**Thiokol A, B and FA** are made from ethyle[illegible] dichloride and sodium tetrasulphide, or fro[illegible] dichloroethyl ether and sodium tetrasulphide, [illegible] from combinations and modifications of the tw[illegible] Dow Chemical makes them for the Thiokol Co[illegible]

*See the glossary at the end for technical (and non-metallurgical) terms.

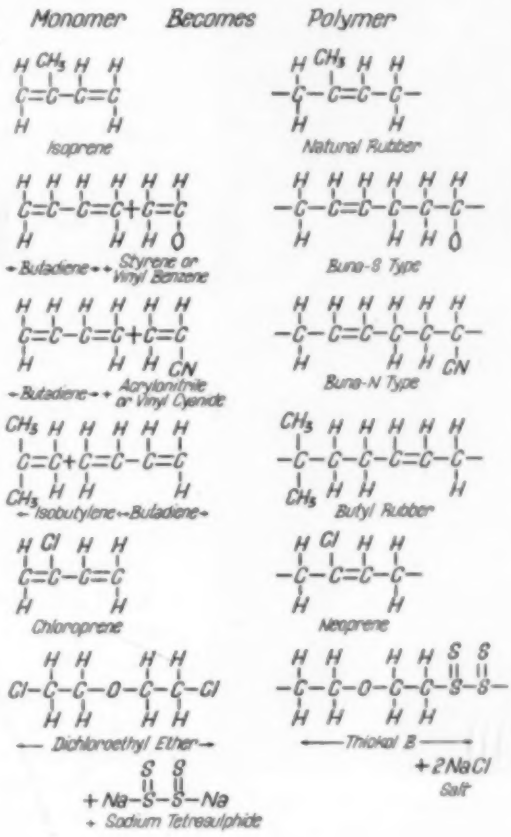
**Comparative Properties of Rubbers**

U. S. Rubber Co.

| Property | Buna-S Type | Natural Rubber | Buna-N Types | Neoprene Types | Butyl Type | Thiokol Polysulphide Type |
|---|---|---|---|---|---|---|
| Form in which available | Latex and solid forms | Latex and solid forms | Latex and solid forms | Latex and solid forms | Solid form | Dispersion, solid & powder |
| **Properties Important in Processing** | | | | | | |
| Breakdown | Good | Very good | Fair | Good to very good | None | Slow |
| Plasticity range after breakdown | High to low | High to low | High to medium | High to low | Medium | High to low |
| Building tack & cohesion | Fair | Excellent | Fair | Very good | Good | Fair to good |
| Vulcanizability | Very good | Very good | Very good | Very good | Fair to good | Fair |
| General processability | Good | Very good | Fair | Good | Fair | Fair |
| **Physical Properties Important in Application** | | | | | | |
| Extensibility | Excellent | Good | Good | Excellent | Excellent | Good |
| Resilience | Excellent | Good | Fair to good | Very good | Low | Good |
| Tensile | Excellent | Fair to good | Good | Very good | Good | Fair |
| Electrical properties | Excellent | Excellent | Fair | Fair | Excellent | Fair |
| Impermeability to gases | Good | Good | Good | Very good | Excellent | Excellent |
| Impermeability to water | Good to very good | Fair to good | Fair to good | Fair to good | Very good | Very good |
| Resistance to plastic flow | Very good | Good | Good | Good | Fair to good | Low |
| to abrasion | Very good | Good to very good | Good to very good | Very good | Fair | Low |
| to tear | Very good | Fair to good | Fair to good | Good | Fair to very good | Fair to good |
| to heat | Good | Fair to very good | Fair to very good | Very good | Fair | Low |
| to cold | Very good | Very good | Fair to good | Fair to very good | Good | Fair to good |
| **Chemical Properties Important in Application** | | | | | | |
| Resistance to air | Fair | Good | Good | Excellent | Excellent | Excellent |
| to ozone | Inadequate | Inadequate | Fair | Excellent | Excellent | Excellent |
| to light | Fair | Fair | Low | Excellent | Excellent | Excellent |
| to petroleum | Low | Low | Excellent | Good | Low | Excellent |
| to aromatic oils | Inadequate | Inadequate | Fair | Low | Inadequate | Excellent |

## Their Structural Chemistry

All this stands forth clearly in the structures of the molecules which take part in rubber chemistry. These symbols, for natural rubber and the five major synthetics, are→




## Manufacturing Processes

Let us take Buna-S as the example of manufacturing processes involved in the production of synthetic rubber. This involves the production of the raw materials (butadiene and styrene) and their polymerization with a catalyst under heat and moderate pressure. Both butadiene (a gas) and the liquid styrene are synthetics themselves.

Butadiene may be made from benzene, acetylene, alcohol (derived from molasses, corn and other grains) or petroleum. The gas is easily liquefied and stored in carbon steel tanks with safety valves set at only 100-lb. pressure.

Styrene is a dehydrogenated product of ethyl benzene. Ethyl benzene in turn is a combination product of ethylene (from alcohol or petroleum) and benzene (from coal tar or petroleum). Processes vary as to the raw material, of course. It is clear that the supply is almost limitless, once the processes are smoothly working. Storage is also in welded carbon steel vessels with safety valves at 100 lb.

In the synthesis of Buna-S three parts of butadiene and one part of styrene are mixed and emulsified in a soapy solution. Polymerization then begins. A catalyst and increased heat accelerate the process. The mixture thickens. Droplets become solid flocs or crumbs of rubber-like substance. They float to the surface of the solution, are screened off, washed, squeezed dry, dried further, and compressed into handy loaves. The loaves go to manufacturers of rubber products.

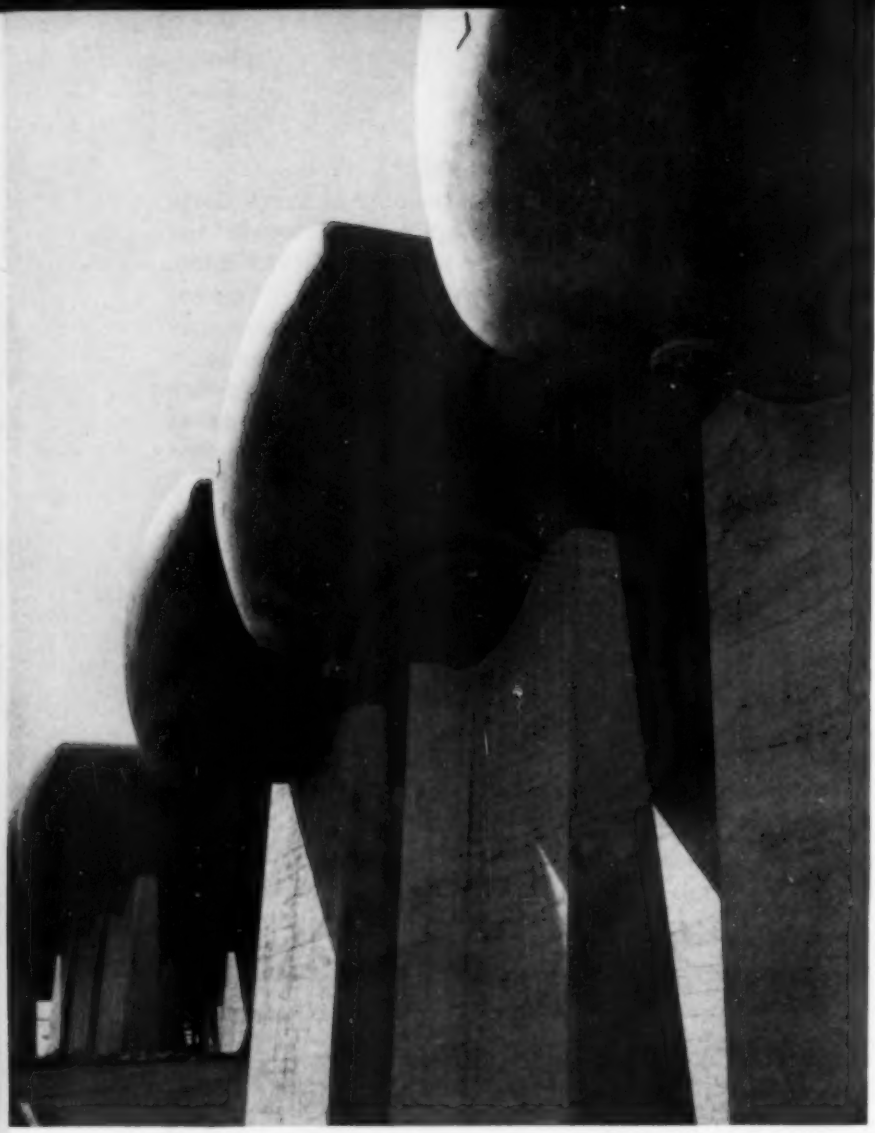
Commercial production follows this procedure on a vast scale. In this way 15 plants are now making this material under supervision of the Federal Government's Rubber Reserve Corp. One of these alone occupies 77 acres in the Kanawha River valley 12 miles from Charleston, W. Va. Here Union Carbide & Carbon Chemical Corp. makes butadiene and styrene, and pipes them to a tank farm in the area where United States Rubber takes over. From here alone has come 20% of our Buna-S output.

The tank farm near Charleston (and it may be taken as typical of the largest plants) includes hydrocarbon storage facilities, a hydrocarbon pump house, liquid chemical storage (sulphuric acid, caustic soda solution), water pump house (all water is treated to prevent rust and slime formation), cooling towers, brine preparation and cooling stations, and a safety flare kept always burning as a sign that vagrant gases are being caught and safely dissipated.

In pigment preparation buildings are barrels, bags and drums of ingredients, such as soap powder; and refrigeration units. Here, too, water solutions of emulsifier, catalyst, reaction stopper and rubber anti-oxidant are prepared and pumped to reactors.

A reactor (page 1096) is a jacketed, agitated autoclave or pressure vessel, often lined with glass. Systems for circulating hot and cold water maintain exact control of the reaction temperature, which ranges between 120 and 130° F. To prevent loss of the volatile butadiene the stuffing box has a special Dura-metal seal which acts on the principle of sliding rings, similar to those in domestic refrigerators. The pressure relief valve (set at 150 lb.) has a combination of frangible or "rupture" disk and spring tension; it discharges to the safety flare through a collector system of pipes. A brace of glazed portholes allows a bright light to illuminate the agitated contents of the reactor and an observer to see the maturing of polymerization.

Ingredients enter the reactor through pre-set meters. In a central control room recording and controlling devices assure that exact temperatures and pressures are kept at all times and stages of operation.



*Steel Tanks, Each of 30,000 Gal. Capacity, Resting on Concrete Cradles, Store the Butadiene and Styrene, Reagents From Which Synthetic Rubber Is Made. All photos courtesy United States Rubber Co.*

The batch process prevails in the synthetic rubber industry. A standard reactor carries a load of 3300 to 3700 gal. and a turbine driven agitator mixes the contents of butadiene, styrene, catalyst and adjuncts. When reaction (or polymerization) ends the vapor pressure of 100 lb. developed during the process serves to expel the latex through the bottom of the reactor and on into processing equipment.

Unpolymerized hydrocarbons are carefully recovered both for economy and to cleanse what is now synthetic rubber.

This freshly formed latex now is protected by admixture of an anti-oxidant. Salt and dilute sulphuric acid further coagulate the latex, which is then washed and squeezed partially dry. Hot air removes the rest of the moisture. The final step, to package the product conveniently and in standard form for the rubber processor, is to compress the dry latex flocs into rectangular blocks measuring 14 by 28 by 6 in. and weighing 75 lb. Rubbermen call these blocks "loaves". They are the equivalent of the metalworker's copper "slabs", tin "blocks", zinc "cakes", iron "pigs".

## Metallurgy Involved

The metallurgy involved in these vast conglomerations of containers, pipes and pumps had to consider resistances against corrosions more than against pressures. Very little bronze or brass could be used because they would affect the latex or the other manufacturing substances. However, acid-resistant bronzes did prove useful in certain special instances.

The metal of choice throughout would be stainless steel; clad steel was widely used for the sake of sparing the precious alloys, chromium and nickel. Much solid stainless had to be put to work, however. Pressure vessels are generally built of Type 304 or Type 347. Type 304 contains a minimum of 18.0% chromium and 8.0% nickel and is low in carbon. Type 347 contains 17.0% min. chromium, 9.5% min. nickel and, as a stabilizing element, 10 times as much columbium as carbon. Type 347 was preferred for its easier welding characteristics; after welding it requires no heat treatment to prevent corrosion in the seams.

In some installations vessels and piping have glass linings to help protect against corrosion. The durable smoothness of the glass is another factor, and this may well give metallurgists cause for invention. Experience in some of these synthetic rubber set-ups showed that a film of latex would often adhere to the walls of bare steel vessels. Workmen had to scrape this away. They used wire brushes. The wire scratched the steel enough to give succeeding batches of latex better purchase, causing more trouble. Glass lining was found to resist the wire brushing effectively.

The dryers of the floc still require metallurgical attention. In these dryers alternate flights moving in opposite directions carry the floc. These flights have punched-out perforations. In stainless flights the punching frequently leaves burrs to which the latex may stick. Punched monel metal causes less trouble.

Steam used to clean the latex also causes trouble by corroding the chains within the machines. Therefore there is a demand for stain-

less chain in these details of the equipment.

Rust which may get into the latex is easily strained out. Bits of steel, bronze or other metals which may happen into the latex can be detected by the electronic devices the Army uses to detect land mines, and then cleaned out.

Catalysts are a prime requisite for polymerization, and each synthesizer has his preferences both as to kind, whether metallic or chemical compound, and as to use. There physical chemistry touches both the realism of the sub-atomic world and the mysticism of trade practices. The whole subject requires unshrouding, clarification and explanation. This much the hermetic magisters of the synthetic rubber autoclaves are at present willing to say about their favorite catalysts: They often are persulphates, say, of sodium or ammonium.

## Synthetic Rubber Glossary

Every technical field has its special argot. Herewith is part of rubber's:

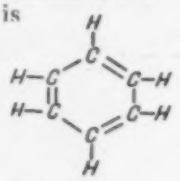
**Acrylate Resins** — Glass-clear flexible thermoplastics made by polymerizing esters of acrylic acid. Ethylene, sodium cyanide, methyl alcohol are the principal raw materials. Formerly used for making safety glass and for brush handles. Now used for making transparent noses and turrets for bombers.

**Adhesion** — The measure of the strength with which one material sticks to another. Some rubber and synthetic compounds will stick to metal and may be used as tank linings. Other compounds will not.

**Aliphatic Hydrocarbons** — Hydrocarbons having an open chain structure. These include rubber, gasoline, kerosene, paraffin.

**Aromatic Hydrocarbons** — Hydrocarbons derived from or characterized by the presence of the "benzene ring"; examples are benzene, naphthalene, toluene.

**Benzene Ring** — An arrangement of atoms in the benzene molecule, $C_6H_6$, united in a way that is not too well understood, but thought to be responsible for the common properties of organic compounds containing the "ring". Its conventional presentation is



**Chlorinated Rubbers** — Derived by passing chlorine gas into a solution of rubber in solvents like chloroform or carbon tetrachloride. Normally contain about 65% combined chlorine.

**Cold Flow** — If subjected to pressure for a sufficient time, no organic material will return to its exact original shape. This change is called cold flow; metallurgists would call it "creep".

**Compression Set** is the amount by which a small cylinder of rubber fails to return after being subjected to cold flow. Synthetics vary widely in cold flow resistance. In mountings under heavy equipment some synthetics would tend to pancake.

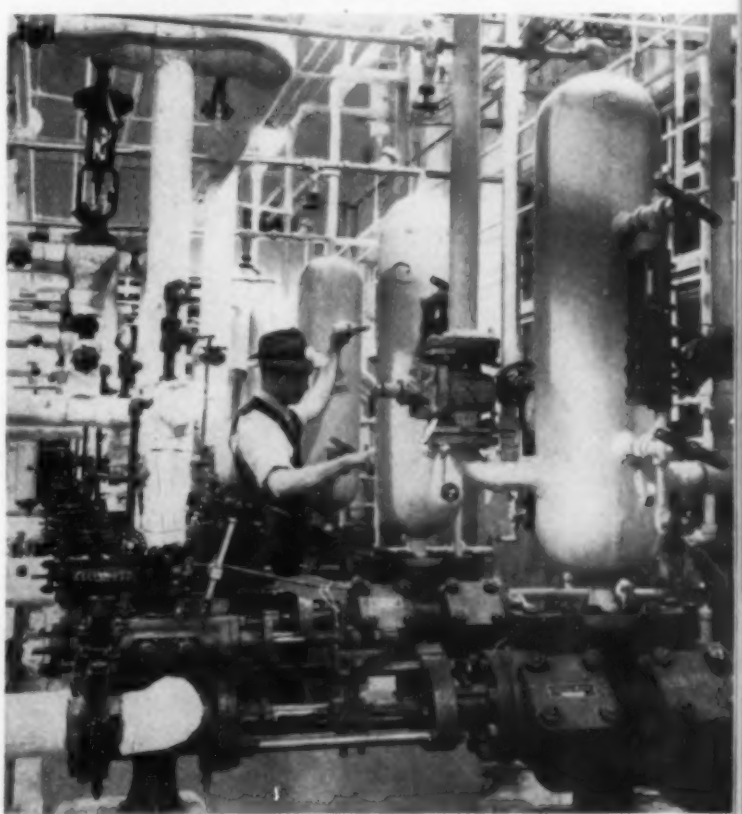
**Co-Polymer** — A giant molecule formed when two or more unlike monomers are polymerized together. See **Polymer.** If a polymer is like a long train of box cars, a co-polymer is a mixed freight of box and tank cars alternating in any proportion such as three box cars and one tank car.

**Cure** — Curing is the rubber factory word for vulcanizing. Rubber and some synthetics are cured, or vulcanized, by mixing with sulphur and heating. Other synthetics differ from rubber in that they can be cured by heating without sulphur.

**Factice** — A rubber substitute made from vegetable oils by treatment with sulphur or sulphur chloride. They are classed as softeners; and are used in erasers, soft rubber rolls and sheetings.

**Flex-Cracking** — Rubber articles subjected to repeated flexing, or bending, develop small cracks

*The Pumps Move Butadiene, Styrene, Special Chemicals and Washing Solutions From Storage to the Autoclave Reactors under Meticulous Observation and Automatic Control*



on the surface. As flexing is continued such cracks become larger and larger until failure may result, as in a belt or tire side-wall.

**Hydrocarbons** — Compounds containing only hydrogen and carbon, as methane, acetylene, benzene, rubber.

**Isomerized Rubber** — Rubber treated with phenol sulphonic acid. Used chiefly as adhesives and chemically resistant paint.

**Latex** — The milky white sap of plants which contain in solution the gum resins from which rubber, gutta-percha, chicle and balata are made.

**Milling** — Mixing by passing between rotating steel rolls, called a mill, to plasticize them and to incorporate compounding ingredients.

**Mineral Rubbers** — Certain slightly elastic bituminous materials made by blowing air through petroleum residues. Used to insulate code wire and in certain mechanical goods.

**Monomer** — A material composed of molecules corresponding to the individual units of a polymer and capable of being polymerized.

**Nylon** — A condensation product of hexamethylene diamine and adipic acid. (Stockings!)

**Permanent Set** — Percentage increase in length, by which an elastic material fails to return to its original length after being stretched for a standard period of time.

**Plastic** — A solid which can be permanently deformed or molded by the application of pressure.

**Plasticity** — A measure of the ease with which a solid can be permanently deformed, that is, molded, extruded or milled by the application of pressure.

**Polymer** — A polymer is a giant molecule formed when hundreds or even thousands of the original molecules of the material have linked up together end to end, as box cars in a long train. Polymerization is an essential condition of any rubber-like material. Closely related to stretch, bounce, long range extensibility, resiliency.

**Polyvinyl Plastics** — Synthetic thermoplastics derived from acetylene. When suitably plasticized they may be substituted for rubber in many uses.

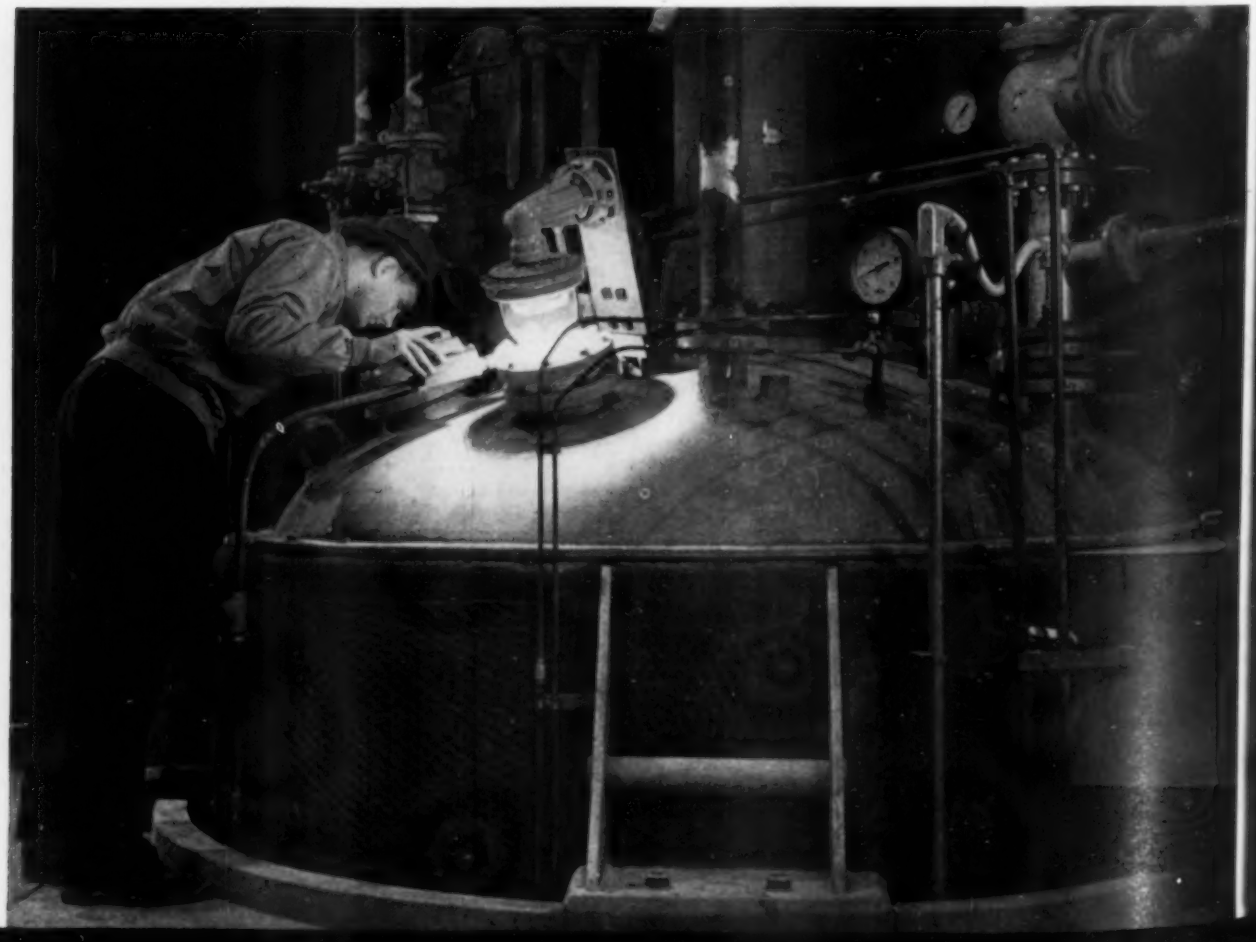
**Rubber Hydrochlorides** — Derivatives of rubber prepared by treating rubber with hydrogen chloride or hydrochloric acid. They have high resistance to oil and water.

**Thermoplastic** — Refers to a solid which becomes soft, or plastic, when heated, as glass, wax, unvulcanized rubber.

**Thermosetting Plastics** — Solids which change from a plastic to a non-plastic state when heated.

**Viscosity** — The internal friction or resistance to change of form of a liquid. The "thickness" of a liquid in respect to flow; opposite of fluidity.

*In Such Autoclaves, Called Reactors, Butadiene Polymerizes With Styrene to Form Synthetic Rubber. Careful design of agitators saves considerable alloy steel. Vessel is jacketed, has temperature-stabilizing devices and various inlets for reagents, instrumental control and observation. Process is intermittent, so easy and complete discharge and cleanup is another requirement*



## NICKEL ALLOYS AID THE CHEMICAL INDUSTRY
## *to* KEEP 'EM PRODUCING!

*Stainless Steel Lined Polymerization Reactors in Synthetic Rubber Plant*

### *Equipment of Stainless Steel, Nickel and Monel meets many specialized requirements*

Chemical engineers have met America's wartime challenge.

They opened the gates to a mighty flood of products going to war...strategic raw materials, synthetic substitutes, and entirely new substances having advantages all their own.

A factor in this production success is the wide use of stainless steel, Monel, and other corrosion-resistant alloys containing Nickel.

For in the chemical industry corrosion is a large-scale menace.

To wage war on this enemy, chemical engineers enlisted the aid of Nickel, because Nickel imparts to other metals strength and resistance to corrosion and wear. In the chemical field, as in many others, a little Nickel goes a long way to keep equipment producing.

It prolongs the life of processing apparatus, and protects the purity, color, and uniformity of the product.

Hence, stainless and Nickel alloys are specified widely for acid heaters and caustic coolers, for high-pressure autoclaves and vacuum evaporators, for cracking towers and polymerization reactors, for shipping drums and tank cars, for pumps, piping and storage tanks, for agitators and settlers, for stills and digestors—for every type of equipment that converts laboratory experiments into full-scale chemical operations.

For years we have enjoyed the privilege of cooperating with technical men of the chemical industry...and of many others. Whatever your industry may be ... if you want help in the selection, fabrication, and heat treatment of alloys ... we offer you counsel and data.

**New Catalog Index**

New Catalog C makes it easy for you to get Nickel literature. It gives you capsule synopses of booklets and bulletins on a wide variety of subjects—from industrial applications to metallurgical data and working instructions. Why not send for your copy of Catalog C today?

★ Nickel ★

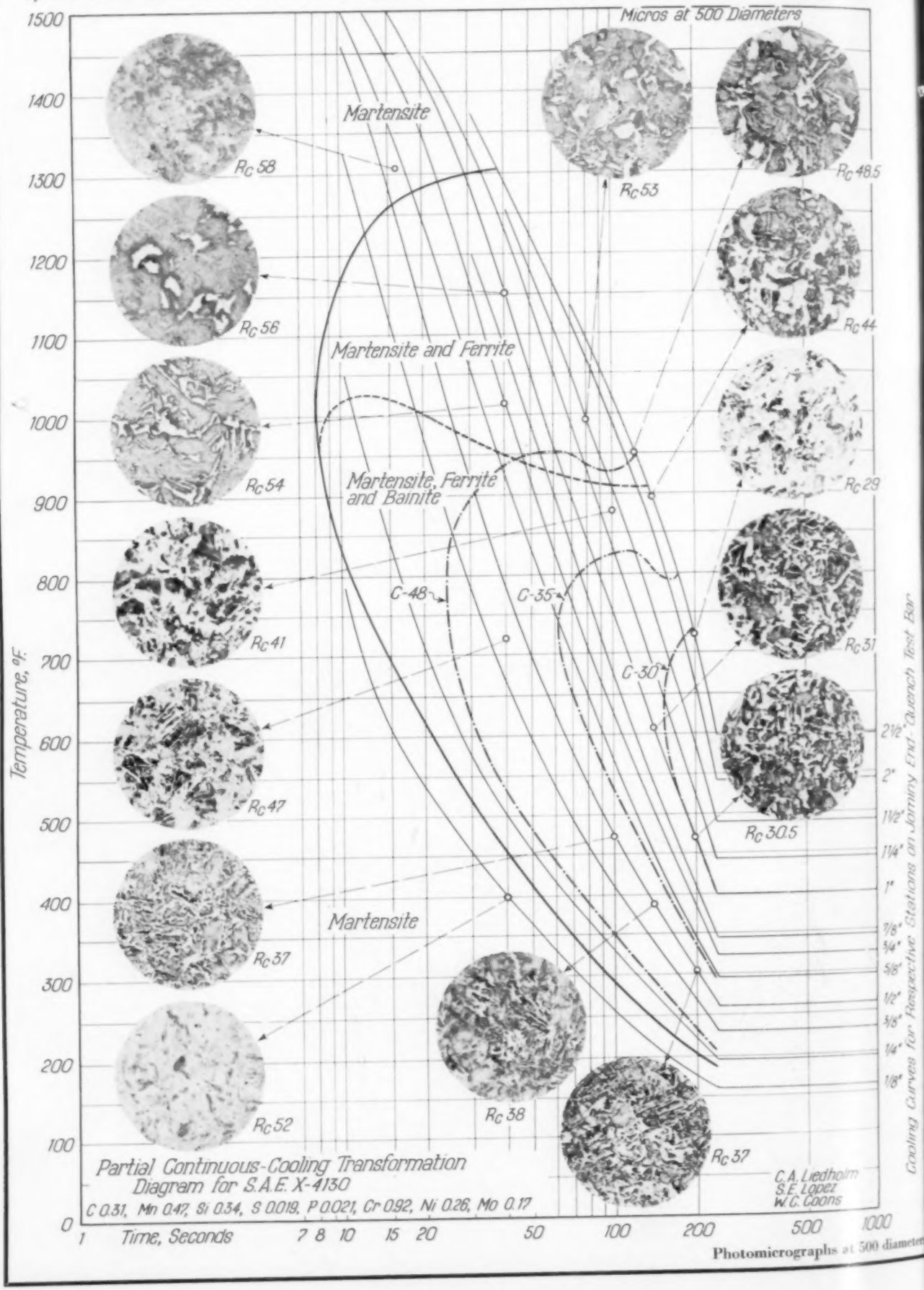
**THE INTERNATIONAL NICKEL COMPANY, INC.,** 67 Wall St., New York 5, N. Y.

# Transformation of X-4130 Steel

## *During Continuous Cooling*

By C. A. Liedholm and Associates, Curtiss-Wright Corp.

See page 1097 and *Metal Progress* for Jan. 1944, page 94



# Diagram of Transformation During Continuous Cooling of Steel

## (A Necessary Guide for Propeller Heat Treatment)

By C. A. Liedholm
Chief Engineering Metallurgist
Propeller Division, Curtiss-Wright Corp.
Caldwell, N. J.

*A contribution to the Group Meeting on "Heat Treatment" at the ASM Convention, Cleveland, October 20. A simple method of plotting these diagrams (similar in nature to the S-curves or TTT-curves for isothermal transformation except they record the occurrences during total quenches of any practicable velocity) has already been described in detail in Metal Progress for January 1944. In addition to a summary of this information, the originator now shows how the diagram has been invaluable in controlling the die quenching under internal pressure of hollow steel propeller blades.*

REGARDLESS of the length of propeller blade, which may be from 4½ to 8¾ ft., hollow steel blades made by Curtiss-Wright vary in material thickness between about $\frac{1}{16}$ in. at the tip and 1¼ in. at the shank in the semi-finished condition wherein they are quenched. The blades are quenched in a die under the application of a total external pressure of 1000 to 1500 tons (depending on the blade size) and an internal pressure of 800 to 900 psi. The purpose of die quenching is to hot straighten the blades and harden the steel uniformly in one and the same operation. For those who have not read about the construction of welded steel blades, a longitudinal and some transverse sections of a typical one are shown in Fig. 1.

The mechanics of the die quenching operation are quite simple; they consist merely in transferring the blade from the furnace to the die, positioning the blade, closing the die, applying first the external and then the internal pressure, and finally, applying auxiliary quench water over those sections which are too heavy to quench through die contact. The quench water is admitted through holes and channelled through grooves in the die and "punch" (Fig. 2), the latter swinging like the breech block of a field gun. Water jackets keep the rest of the die and punch cold during the operation.

Now consider what happens metallurgically to the steel during the operation described above. Briefly stated, it cools — first in air, then in the die or in a stream of water. The final result must be a quenching sufficiently complete to permit tempering the entire blade back to Rockwell C-27 to C-33. Because the blades are handled manually, the air cooling period varies in time from blade to blade. The cooling cycles vary from one in which a 1¼-in. section cools from one

side only to one in which a $\frac{1}{16}$-in. section cools in the same way. Then the cycles are changed abruptly as the blade contacts the die and punch, and again as the water stream is turned on. To control this complex operation, it is obvious that the air cooling period must be limited, the time allowed for application of internal or external pressures must be limited, and the delay before the water is turned on must be limited, or the steel will begin to transform to ferrite and other transformation products before the cooling liquid strikes it and it can be adequately quenched.

Perhaps the complications attendant to the die quenching operation now can be realized. This brief discussion will be the attempt to show how the metallurgical riddle of die quenching a propeller blade can be analyzed in a very simple manner if a "continuous cooling transformation diagram" (constructed as described in *Metal Progress* last January) is available for the steel that is being used or contemplated. It will be attempted also to show that no other type of experimental results or hardenability data can do the job in a fully satisfactory manner. At least we made several other attempts before devising the successful scheme.

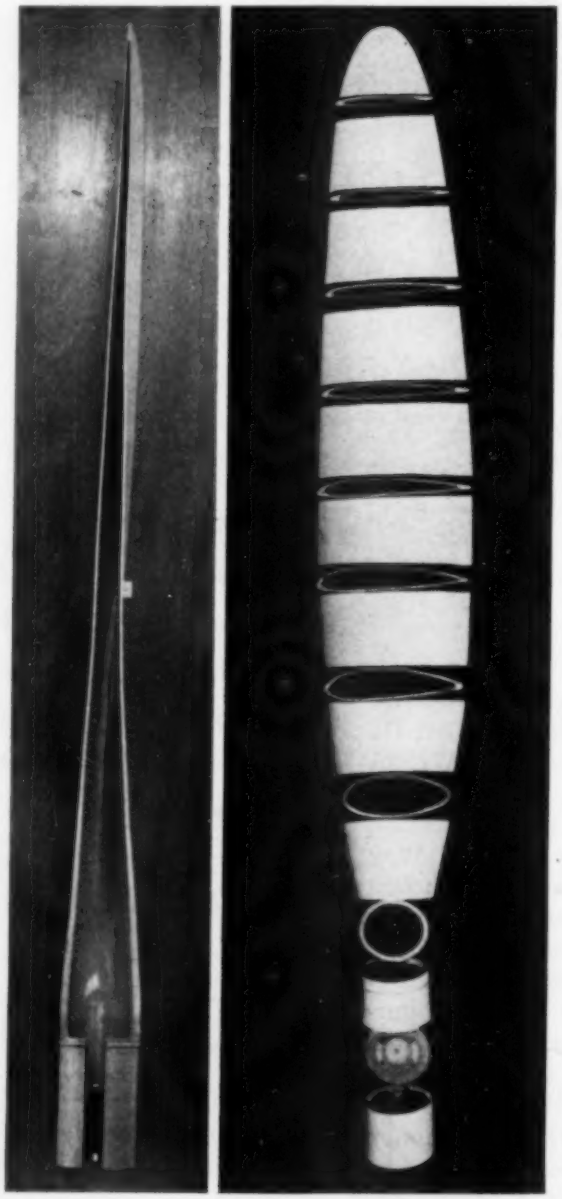


*Fig. 1 — Longitudinal and Transverse Sections Through a Hollow Steel Propeller*

First, suppose we try to develop shop specifications for die quenching on the basis of direct experimentation, namely, by quenching actual blades with different timing in the sequence of operations. Such a scheme will need several full-sized blades made from a steel heat of the minimum hardenability that is possible or likely to be received within the analysis range of our purchase specification. One blade will not do the job, for we want to know *how long* we can delay our final die and water quench without endange ing the physical properties of the blade. Unle we establish exact time tolerances, our shop spec fication may impose undue hardships on produ tion, and we must either re-treat blades that w thought were handled t slowly, or scrap them, take a chance on lettin them through to fin inspection. So we wa until we have enou blades of low hardenabi ity steel, we quench the with various die an water quench delays, an then we section them 3 to 6-in. intervals f hardness surveys. Sin the price of a blade ru into hundreds of dolla the costliness of th method as a productio control, aside from lab ratory and sampling tim is excessively great, say nothing of delays finding the extreme ty of steel.

Figure 3 shows t results of attempting attack the problem fro another angle. It contai 12 cooling curves tak at various stations *on t inside* of a large hollo steel blade cooled eith in a die or in air (no malized). The idea w to collect such curv with a Speedomax recor ing instrument from number of successive st tions at both edges a at the mid-points of t corresponding propell faces. To determine t theoretically permissib quench delay, thes curves were to be plotted on the cooling-tra formation diagram derived by Grange a Kiefer's method from the S-curve of isotherm transformation for the steel being used. T difficulties were that each of the curves plott in Fig. 3 required a new blade because some sca ing occurred during each cooling cycle and, addition, it was quite a feat to avoid fouling u the thermocouple or its leads when a blade w

transferred from the furnace to the die, or when the breech block was closed and the internal pressure was turned on.

These 12 curves in Fig. 3 required the use of busy production equipment; they were obtained through much labor, blessed by none and appreciated by few. They were too erratic to be used for a systematic analysis of the die quenching operation but they brought home one important point: The mere die cooling of the heavy and medium sections (which are stiff and yield but little to an internal pressure that forces the thinner surfaces into correct conformation in the die) depends less on the section thickness than on the snugness of their fit (the blade is still in the semi-finished condition in the die.)

We then turned to Jominy's end-quench test. A single sample contains *all* the cooling rates possible in a blade except the very, very slow ones; it will show if the 1¼-in. shank sections can or cannot be hardened through by applying a water stream on the outside of the hollow shank. But it will *not* show what happens when the cooling rates change suddenly in the middle of the die quenching operation. In its standardized procedure it will only show the various end results of different uninterrupted cooling cycles; it will not show the time or temperature when transformation to undesirable soft products begin. It also gives no information about permissible pre-quench delay.

Suppose, however, that we treat a series of Jominy test pieces in the same manner as propeller blades, thus: First quench in the fixture with the quenching stream striking the end for a measured time (varying the duration of the end-quench period from sample to sample) — then quench the *entire* specimen in brine. The time the hot sample remains in the jig will represent the time preceding the instant when full die contact and quench has been applied to a propeller blade; thus the end-quench period can be made to show what will happen in a blade during any arbitrarily selected quench delay. The air-cooling of thin, medium, or thick propeller blade sections will be duplicated somewhere on the Jominy bar. If the test bar has a fairly uniform hardness after a 15-sec. end-quench period, then the propeller blades made from the same steel will be equally uniform in hardness after a 15-sec. quench delay, provided the eventually applied quench is sufficiently drastic. But if the test bar shows a dip in its hardness curve from quenched end to slow cooled end, then a propeller blade similarly quenched will show like variations in thin and thick sections.

Figure 4, from the January article in *Metal Progress*, shows a series of end-quench curves resulting from different quench delays for a heat of S.A.E. 6135 analysis of rather higher hardenability than would be judged by the analysis. (In each curve the horizontal line under the ⅛-in. plotted position represents a hardness of C-50, and the times noted do not include the 3 sec. necessary to transfer test sample from furnace to end-quench fixture.) The curve for the sample cooled 20 sec. in the test fixture shows no drop in hardness along its length; the curve for the sample end-cooled 30 sec. in the fixture and then put into brine is slightly softer ⅜ in. from the end than at the very end. This indicates that a blade of uniform hardness can be obtained with that heat of steel and a maximum quench delay of at least 23 sec., (20 sec. in fixture plus 3 sec. transfer time). A steel of 6130 analysis of *minimum* hardenability, however, tolerates a maxi-

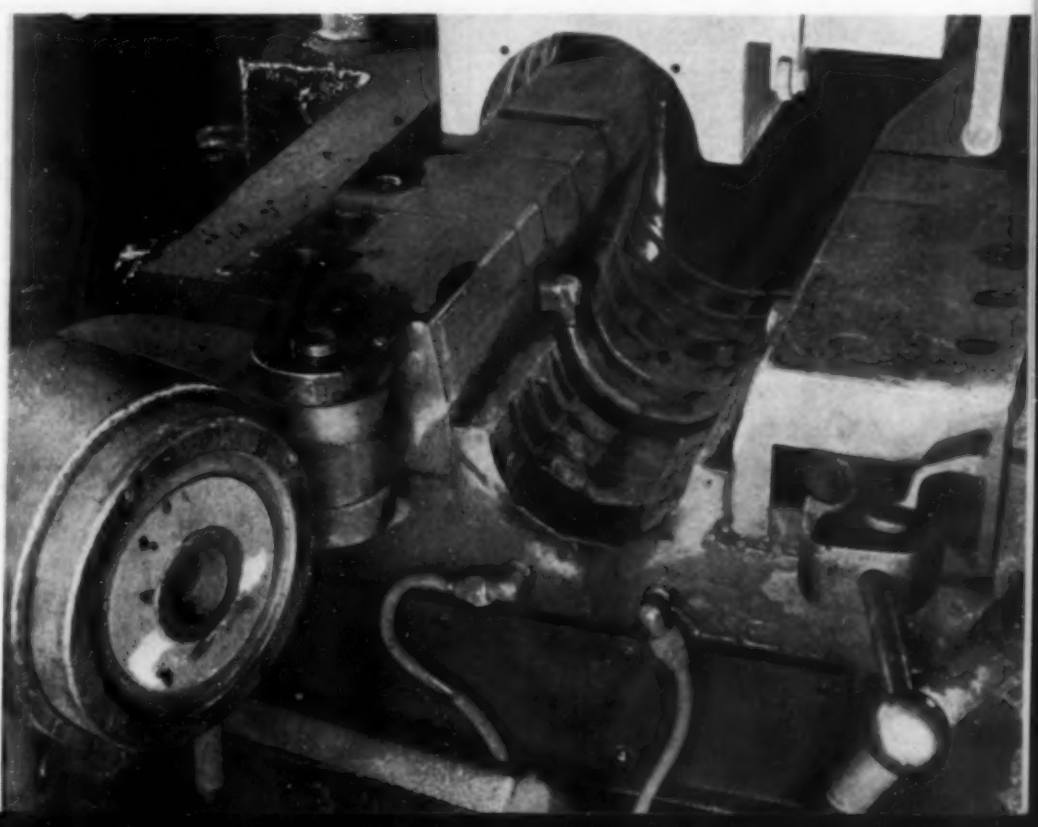


*Fig. 2 — End of Die for Hot Straightening and Quenching Hollow Steel Blade. Note holes and channels for quench water. Pressure water is forced inside the blade through the round "punch", swung aside — like a breech block on a field gun — at left foreground*

mum safe quench delay of only about 15 sec., which is also the maximum required for economical heat treatment of a blade of a certain design.

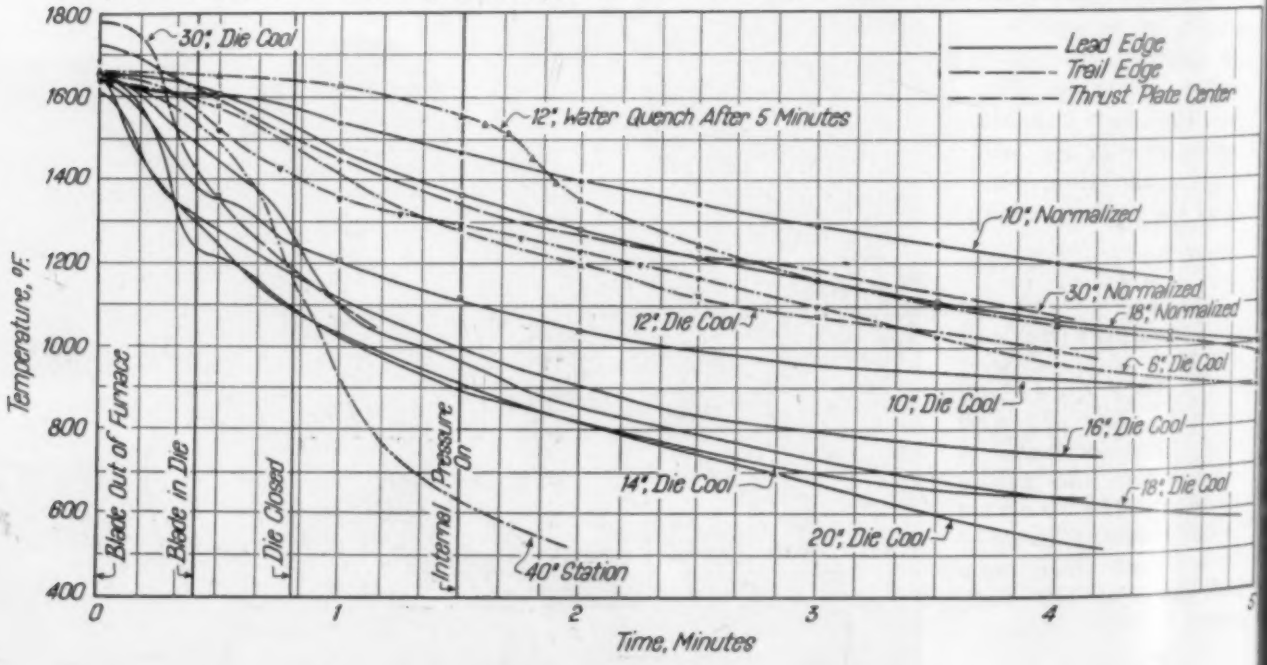
Uniform quenching is necessary in order that the blade after tempering may also have fairly uniform hardness; our acceptance specification for this particular unit admits a tolerance of C-27 to C-33. The results obtained with a 15-sec. maximum delay before quenching, the blade being subsequently quenched, have been checked on over 30 blades from various heats of 6130 steel, and hardness surveys of successive sections have indicated the average section hardness varied no more than between the acceptable limits of Rockwell C-27 and C-33.

Thus, we have arrived at a testing procedure capable of showing what results to expect from various quench delays and, therefore, enabling us to specify the maximum permissible delays for various steels with confidence, on the basis of simple experimental determination. But our heat treating procedure remains entirely unscientific until it is based on a reasonably complete knowledge of the temperatures where various transformations begin, and the corresponding structures formed during various cooling cycles. This information can be obtained only from a continuous cooling transformation diagram and preferably from one which is determined experimentally rather than through theoretical deduction. The procedure whereby such diagrams can be developed through end-quenching of Jominy bars for different periods followed by quenching of the entire bars was described fully in the January article entitled "Continuous Cooling Transformation Diagram, From Modified End-Quench Method". This will now be briefed, in order to explain again the derivation of the diagram for X-4130 steel shown in the data sheet in this issue, page 1096-B, and additional uses for these data will be discussed briefly.

The first step is to obtain cooling curves for the various stations or distances from the quenched end of the Jominy bar. In our work, ½-in. diameter by 4-in. long test bars were used. The cooling curves are plotted on time-temperature coordinates, time being conveniently measured by logarithmic scale, and labeled according to the station on the bar. A number of specimens (21 in our routine) then are quenched in the fixture for various lengths of time. The end-quench period in each instance is interrupted by quenching in iced brine to fix the transformation structures existing at the given time at various distances from the end. The bars are tested for hardness with the results already illustrated in Fig. 4.

In the time-temperature diagram containing the cooling curves (the light lines in the data sheet, page 1096-B) we now may enter the hardness of each station on the time-ordinate corresponding to the end-quench period, plus 3 sec. for the time used in transferring the test piece from furnace to fixture. Points denoting a change in hardness of a certain station from one end-quench period to the next may be connected by "hardness levels" or contours that separate one hardness field from another. Each field will contain an arbitrary range of hardness as desired by the investigator to fit the conditions he regards

*Fig. 3 — Air and Die Cooling Curves for Several Locations 13½-Ft. Hollow Steel Propeller*



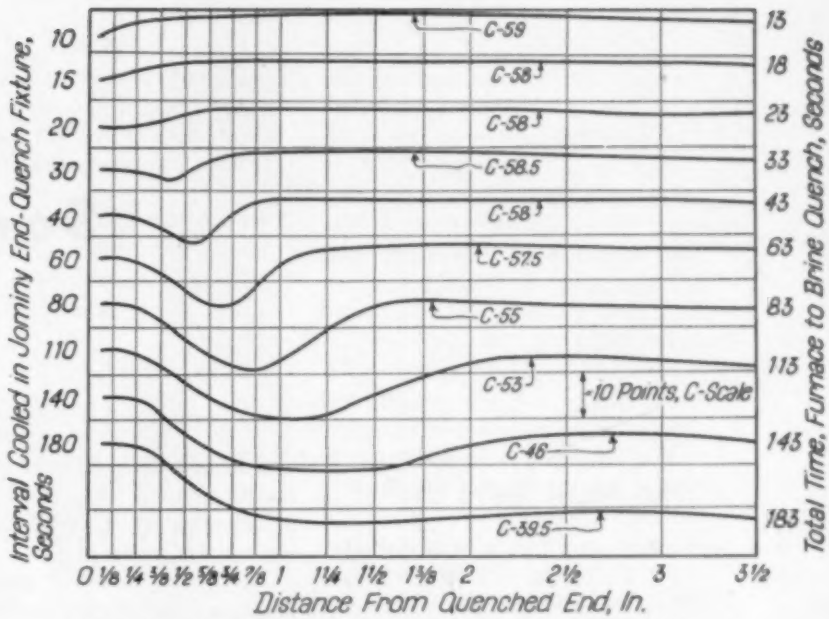



*Fig. 4 — End-Quench Hardness Curves Obtained With Various End-Spray Periods Followed by All-Over Quenching of S.A.E. 6130 Steel in Brine*

as important. The data sheet shows the results obtained thus for a heat of S.A.E. X-4130. To finish the cooling transformation diagram by mapping the regions where certain microstructures exist, judiciously selected sections must be examined by a competent metallographer. His observations will furnish the information necessary to draw the heavy-line boundaries which indicate when various reactions such as ferrite, bainite, or pearlite transformations begin and end. Some continuous cooling transformation diagrams showing the limits of such reactions have been published in *Metal Progress* for January, June, and September 1944.

It is obvious at once that the finished diagrams exemplified by the data sheet give considerably more information and insight concerning the results of various quench delays than any of the other test investigative programs discussed. First of all, they warn that the hardness can be very close to the possible maximum even though ferrite precipitation has begun. Since the Jominy bars, upon interruption of the end quench, were quenched in iced brine, our first thought was that the hardness differences between the martensite formed during cooling in the jig and during the final quench was due to the greater severity of the brine quench. However, the same difference was obtained when the final quench was performed in the cold water in the tank below the spray used for end quenching. The reasons we are unable to explain. Note that, in the data sheet, page 1096-B, structures containing martensite and ferrite had hardnesses of Rockwell C-53, C-54 and C-56, whereas an all-martensite structure formed at the end of the end-quenched test bar (⅛-in. position) was Rockwell C-52. This means that a Jominy hardness curve in Fig. 4 without any dip, obtained through interrupted end-quench, does not guarantee freedom from small amounts of transformation. (A small amount of transformation, however, appears to have no important effect on softening during tempering. A set of bars spray-quenched for various intervals can be used to study the softening of incompletely transformed structures.)

The question as to whether or not a small amount of precipitated ferrite would have any effect on the fatigue strength of a finished blade has been open to discussion. Therefore, it was decided to obtain the cooling curve at the waist of an R. R. Moore rotating beam fatigue specimen and superimpose this curve on the transformation diagram for the same steel. By properly timing the quench delay of the Moore specimen, it was possible to quench it to a structure consisting only of martensite and ferrite, or martensite, pearlite and ferrite. Tempered specimens of this sort now are running to determine the fatigue strength for various amounts of transformations. Additional work in progress will attempt to determine with reasonable accuracy, other physical properties such as tensile strength of incompletely quenched structures with various amounts of transformation products.

It is perhaps obvious now that the development of continuous cooling transformation diagrams for propeller steel serves to deepen the insight with which pertinent studies may be planned and experimental results interpreted. Note, for example, that the complete diagram in the data sheet enables us to select either a quench delay that will prevent the formation of ferrite or one that will merely satisfy specified hardness requirements. The former would be 8 sec. and the latter, based on hardness after tempering, 23 sec. The delays cannot be so closely determined merely on the basis of interrupted end-quench tests.

Before closing, it may be pointed out that, if desired, hardness levels or contours such as shown in the data sheet can be based on interrupted end-quench tests tempered in accordance with the adopted manufacturing practice. Such hardness levels would indicate the possibilities of meeting hardness requirements after completed heat treatment.

# Notes About Some Good Books

## What Metal Shall I Use?

MATERIALS AND PROCESSES, edited by J. F. Young, 628 pp., Wiley, New York, 1944. $5.00.

ANOTHER GAP on the bookshelf has been filled, and well filled, by this new volume.

There have in the past been several books covering some part of the field of materials and processes — I have made frequent good use, for example, of Leighton's "Chemistry of Engineering Materials" which in its present (1942) edition is revised and edited by Professor Warner of Carnegie Tech — but it discusses materials from the standpoint of the chemist, and for general engineering use rather than manufacturing. White's "Engineering Materials" has many excellent features. And the recently published "Selection and Evaluation of Engineering Materials" by Gillett (Penton Publishing Co.) is invaluable both to metallurgist and engineer.

As to processing, there have been several available books such as Boston's "Metal Processing" but none (that I have seen) above the rank of trade school texts are written from the manufacturer's point of view.

This new book was prepared by engineers of the General Electric Co. for use in what is called the advanced engineering program of that company. The preface remarks, with considerable accuracy, that most of the data published on metallic materials are from the metallurgist's viewpoint, and the information usually to be had on manufacturing methods tells *how* to do it, not *when* and *why*, and the former approach leaves a broad gap in the problem of selection of material and process by the designer.

A wide range of subjects is discussed, in all cases with brevity but not sketchily — that is, the subjects are not over-simplified so that the reader might assume incorrectly that he now knew all about it. About a third of the book is devoted to metallurgy and heat treatment of ferrous and non-ferrous alloys, developed from consideration of phase diagrams. There is a good chapter on corrosion, and an excellent discussion of metal casting methods and principles, with emphasis on design for casting. The same attitude makes the chapters on plastics, powder metallurgy, hot working, and cold working very usable. Welding and brazing are well covered in brief manner, a hundred pages being allotted to this section. Machining and inspection, including quality control, are given quick scrutiny.

Many of the various sections of the book are signed by the individual authors, and the entire work is written from the standpoint of designing for modern manufacturing. Its specific aim is, of course, to give information and instruction useful to engineering trainees who will be working in the G.E. plants; three chapters are logically given over to electrical and magnetic materials.

The book is well made, well written, adequately illustrated. Your reviewer is, as no doubt has been noted by now, very enthusiastic about the way a job which needed doing has been done. "Materials and Processes" could very well be used as a college text for courses for mechanical engineers, and offers many possibilities for ⚙ and similar local educational activities.

Lest the praise sound too fulsome, it might be well to cite two inadequacies: The principles of *selection* of steel are rather too lightly touched on, although the non-ferrous metals are more fully handled in this respect, and it was surprising to find no reference to shot peening among the methods for improving fatigue resistance. METALLURGICUS

## A Summer's Reading

SINCE *Metal Progress* has recently gone non-technical in certain respects, perhaps the Editor may gossip a bit about his summer's extra-curricular reading — far more extensive this year than ever before because of an enforced absence from the office chair. In keeping with the times it was mostly of wars, past and present. In fine:

"Lee's Lieutenants, A Study in Command" by Douglas Southall Freeman. Reading of Vol. I was started at the ASM Convention in Chicago a year ago; Vol. II was completed during the summer; Vol. III (just published) will be read as soon as the dear friend who gave the others remembers that I lack it. "Lee's Lieutenants" warrants the praise reviewers have lavished. It vividly emphasizes that Lee and Grant did not fight the Civil war as knights in tourney, but that Lee's ideas were sometimes brilliantly but often imperfectly carried out by dozens

generals whose names are miliar to my generation (but re they come forth as men, jeal- s of their reputations, who eat, ep and swear or pray) as well hundreds of other staff officers ho are not even names any more. hind them are the legions of fantrymen, cavalrymen, artiller- s and sailors perished long since cept for daguerrotypes in hum- e family albums. The war's end as inevitable from exhaustion of uthern resources, not least of hich was the wastage of com- tent commanders, limited in mber as was everything else.

Lest one get carried away with mpathy with the lost cause, rn to "Abraham Lincoln, The ar Years", the four-volume hievement of Carl Sandburg — r superior in craftsmanship and erary merit, in my opinion, to reeman's work. Fitting is choice f author and subject; Lincoln as indeed a man of the plain eople, sprung from the mass and easuring up to the need (as eeds must if civilization is to rvive). Sandburg makes no ffort to smooth over the hero's ough edges. Lincoln's written ords are often as close to poetry s prose can be; fortunate it is at a poet from the great plains, is own country, links them ogether with running commen- ary. (I would wish that every ntending contributor to *Metal rogress* spend an evening on one f Sandburg's volumes before tarting to write, subconsciously imitate this matchless style.)

"A Bell for Adano" — John ersey's character study of an talian-American Major in the llied Military Government in ccupied Territory, and the lieu- nants and sergeants and Italians e got along with famously. ersey, apparently, doesn't like olonels and generals; if you feel e same way you'll like this est seller.

Harry Brown, in "A Walk in he Sun", attempts all too briefly write a plain tale of what hap- ens to a platoon of men working heir way from a newly won each-head a few miles forward to a fortified farm, and what some of the men think, and how they cover their thoughts with grim banter. Raw in spots, but so was their job.

"The Six Weeks' War" by Theodore Draper is a highly illuminating account of the German break-through near Sedan

early in May 1940, and the whirlwind campaign that produced Dunkirk and the surrender of France (the "armistice") on June 25. A military marvel at the time — it just couldn't happen — yet it was repeated in reverse direction in 1944 by Eisenhower's men. Recommended for an understanding of the blitzkrieg, its possibilities and its limitations.

Having read innumerable references to Admiral Mahan's study of "The Influence of Sea Power on History", was also moved to secure a copy and read this analysis of warfare by sailing ships during the years (1660 to 1783) when England was gathering and cementing her empire. Written in 1890, and replete with the tactics of long out-moded vessels, the strategic principles are apparently enduring — at least some of his predictions of a half-century ago about the future naval needs of the United States as they would be affected by a then-unbuilt Isthmian canal are astounding in their accuracy. In the century about which he wrote the guns were continually booming; in succession Holland, then Spain, then France exhausted their treasure and manpower and sank from first to second rate importance. Mahan may somewhat overemphasize the influence of foreign trade on all these brawls, perhaps because of his thesis that a navy is of little importance except to protect commerce; if his contentions are true one wonders whether foreign trade (at least to a fairly self-contained nation) is worth the blood and treasure it has cost.

And then one week-end when there was yard work to shirk, I lost myself in C. S. Forester's "Captain Horatio Hornblower", a commander of a frigate that survived many a bloody battle, a hero who fought himself on the quarter-deck as grimly as he fought his enemies, and who became a weak mere man only when his feet were on the ground.

Lastly were three books, ready for reading but alas not read — if they're all I'm told they are: Lewis Mumford's trilogy beginning with "Technics and Civilization", a history of the machine and a critical study of its effect on civilization. Surely required reading for the Editor of *Metal Progress!*

## Metal's "Innards"

PHYSICS OF METALS, by Frederick Seitz, 330 pp., McGraw-Hill, 1943. $4.00.

IN LATE YEARS there has been a tremendous increase in the knowledge of the physics of metals — what makes 'em tick — although of course a great amount today is still unknown. The work which has been done in this field has appeared here and there, in books and in articles, some of it readily available to the ordinary metallurgist, available both as to location and as to comprehensibility, but much has been unavailable to him in these respects.

Several years ago Hume-Rothery's "Structure of Metals and Alloys", a brief booklet of a hundred pages or so, undertook to discuss part of this work. The recent "Structure of Metals" by Barrett is an excellent scientific presentation, but will not be very usable for the man who had his

*High Speed (55 Mph.) an High Velocity 76-Mm. Rif With 7-Mile Range Ar Only Two Features of th New "Hell-Cat", Tan Destroyer Built by Buick and Proved in the Amer can Army's Sweep Throug Northern France. It weigh 19 tons and is powered b a 485-hp. radial aircra engine with dual control, s mounted as to be easil replaced when needin repairs. Each of the fi riding wheels have indivi ual suspensions, incorpora ing torsion-bar springs an rugged double-acting shoc absorbers. Compensato linkages automatically tak up slack in the track whe moving over obstruction Improved riding qualitie improve the fighting qual ties; simplified control expedite the training o crews. So many battle tested auxiliaries are incor porated in the design tha the "Hell-Cat" has litt relationship to the tank mass produced by the Allie three years ago*

organized education in metallurgy more than ten years ago, because of its highly mathematical nature. The same applies to Seitz's book of a few years ago, "Physics of Solids".

The present book derives from an evening course given for several years by Professor Seitz, who is head of the department of physics at Carnegie Tech. Because of the nature of the audience, says the preface, the lectures were both non-mathematical and elementary. However, since the viewpoint is that of the atomic physicist, when Seitz says "non-mathematical" he means "no calculus". Nevertheless, nearly everything in this book is understandable by any clean-living, clear-sighted metallurgist, although there are some tough spots.

However, the rewards to the reader are very great and will more than justify the time spent in study — even a casual reading will amply repay almost anyone, and repay with genuine interest.

Just as small boys get to wondering about the facts of life, practically everyone who works with metals seems to develop a curiosity as to why they act as they do, and the 21 chapters of this book nicely explain the current ideas of the physicist. Beginning with "atomic arrangements", the nature of alloys, elastic and plastic properties, internal friction and fatigue, and diffusion in metals are discussed. Iron-carbon alloys are taken up in a chapter based largely on the work of Mehl and associates. The last third of the book is devoted to physical matters, more especially, such a electrical and magnetic properties

This book can therefore b heartily recommended to thos who want to know somethin about the high-power investig tions looking toward the "innards of metals. It is a worthy additio to the publisher's "Metallurgy an Metallurgical Engineering Series" which also includes Brick an Phillip's excellent "Structure an Properties of Alloys", Barrett book mentioned above, and others

Now will someone please giv us a similar book on "mechanica metallurgy" to coordinate all th work done in the past few year on significance of test results, tri axial stresses, damping, interpre tation of creep data, and so on A big audience awaits.

METALLURGICUS

**Molybdenum cast steels are meeting practically every requirement involving high temperatures and pressures.**

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

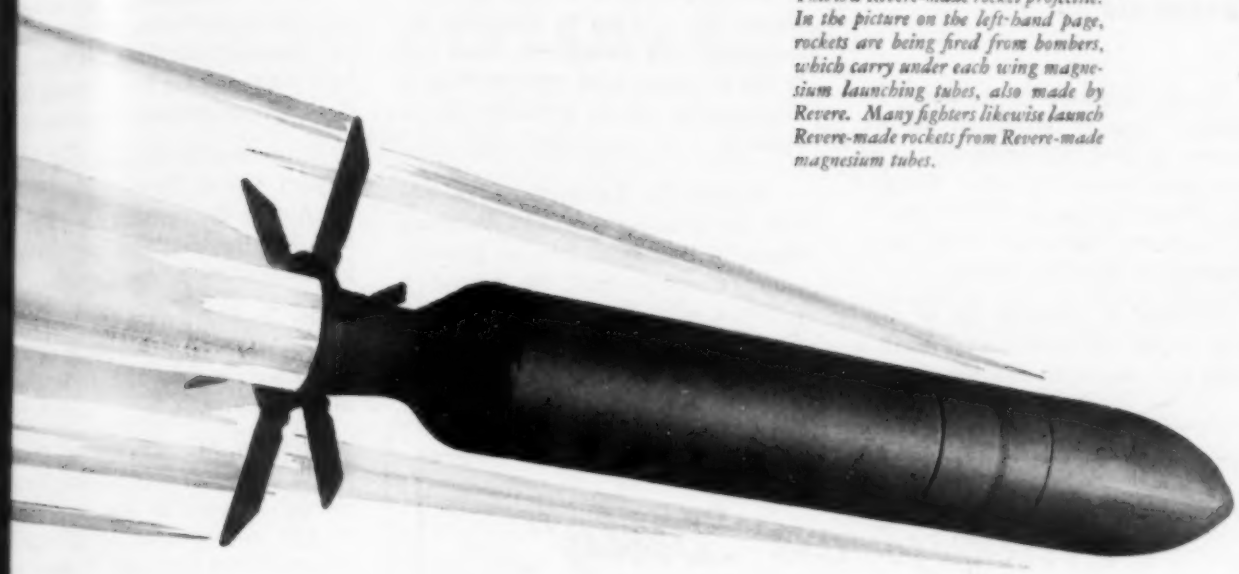
**Climax Molybdenum Company**

**500 Fifth Avenue · New York City**

MOLY

*Metal Progress; Page 1106*

*This is a Revere-made rocket projectile. In the picture on the left-hand page, rockets are being fired from bombers, which carry under each wing magnesium launching tubes, also made by Revere. Many fighters likewise launch Revere-made rockets from Revere-made magnesium tubes.*



# It's GOT to be PERFECT!

## Revere has made over two million rocket projectiles out of Revere Electric Welded Steel Tube

Look at that rocket projectile streaking through the air faster than the airplane flies!

Think of the terrific heat and pressure required to propel that rocket with such amazing speed and accuracy!

And then remember this:—Revere not only developed those projectiles at Army Ordnance request, but has made over two million rocket projectiles and rocket targets out of Revere Electric Welded Steel Tube.

Any steel tube suitable for such a purpose must be not merely good, but PERFECT. It must pass a pressure test of over 5000 pounds!

### Rocket Projectile Facts

Propelling charge is a special powder producing great heat and pressure as it burns.

High-explosive head contains pentolite, 20% more powerful than TNT.

Projectile has the devastating effect of a 105-mm. shell.

Unlike a shell, a rocket is fired without recoil, and hence can be discharged from a plane, from ships too small to carry artillery, or from light launching apparatus used by ground troops.

Rocket projectiles are used to destroy fortifications, tanks, planes, ships, submarines, and against enemy troops, in France, Italy, Russia, and the Pacific.

They are probably the most effective of projectiles per pound and per dollar.

Thus the war comes rocketing to an earlier end!

### What this means to YOU

It will be great good news to you that today our facilities are so large that we are once again able to fill commercial orders, on a priority basis only.

If you need steel tube for boilers, condensers, water and steam lines, or for general pressure or mechanical applications, consult Revere. We will not only supply high-pressure electric welded steel tube, but will cooperate with you in working out any problems in specifications, selection or installation. Revere has been welding steel tube electrically for 25 years. We *know how*.

May we work with you *now* in formulating your plans for the use of steel tube?

**REVERE**

**COPPER AND BRASS INCORPORATED**

*Founded by Paul Revere in 1801*

*Executive Offices:* 230 Park Avenue, New York 17, N.Y.

*...rt at left reproduced from original by Robert Lindgren, ...Editor, AIR NEWS, September issue.*

## Personals

C. W. SCHEMM, formerly industrial heating specialist of the General Electric Co. in the St. Louis area, has joined the Ajax Electric Co., Philadelphia, as sales engineer in northern California with headquarters in San Francisco.

GUSTUF A. OSTROM is now with Foote Mineral Co., Philadelphia, as a research engineer.

Promoted from ensign to lieutenant (j.g.): JACK B. NEWKIRK, formerly with Bethlehem Steel Co. in the laboratory, at present with a de-gaussing unit at a Pacific Naval Base.

GEORGE T. KAMPMEYER has left the Nicaro Nickel Refining Plant, Wilmington, Del., as production superintendent, to accept a position with the Hi Alloy Casting Co. of Elwood City, Pa., as general foreman in charge of melting.

W. S. MOELLERING, formerly with the Steel Products Engineering Co., Springfield, Ohio, is now district manager for the Airtemp Division, Chrysler Corp., Dayton, Ohio.

Promoted by United States Steel Export Co. of New York: ALFRED W. ALLYN, formerly manager of the Montreal Office, to assistant regional director for Canada.

R. H. STEINWALL has joined the Eau Claire, Wis., plant of Western Electric Co., and is in charge of the toolroom.

JOSEPH W. ATKINSON, formerly with Parsons Marine Turbine Corp., is now in the engineering design department of George G. Sharp, Naval Architect in New York.

J. R. LOW, JR., formerly assistant professor of metallurgy, Pennsylvania State College, is now development engineer, research and technology department, Carnegie-Illinois Steel Corp., Pittsburgh.

GARY STEVEN, formerly metallurgist for Summerill Tubing Co., Bridgeport, Pa., is now senior methods engineer, in charge of metallurgical section, Materials Testing Laboratory, Curtiss-Wright Corp., Airplane Division, Buffalo, N. Y.

ALBERT R. FAIRCHILD, JR. has resigned as metallurgist with Tri-State Heat Treating Co. to return to New York Shipbuilding Corp., Camden, N. J., as metallurgist in charge of heat treating.

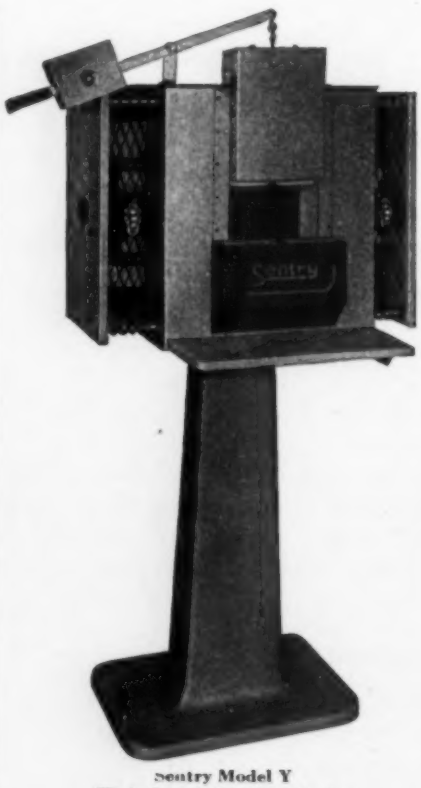
CLARENCE W. FABEL has resigned from the research laboratory of Curtiss-Wright Corp., to accept the position of metallurgical engineer with the Gorham Mfg. Co., Providence, R. I.

JACK B. HALL, formerly process engineer for Curtiss-Wright Corp. in Buffalo, is now quality control field representative for the subcontract division at Globe Aircraft Corp., Fort Worth, Texas.

WALTER D. HAZLETON has been appointed sales engineer for the Electro-Alloys Co. in the Detroit area.

ALBERT M. SHOWALTER has accepted a position as experimental research chemist with International Minerals and Chemical Corp., Esto Point, Ga.


"Always on Duty"




Sentry Model Y
High Speed Steel Hardening Furnace

This Sentry Slogan describes the reliability of Sentry Furnaces. Always ready for use on short notice.

Rapid heating—1 hour to 2350° F. Well suited to intermittent use requirements. Ideal for Tool Rooms. No Fumes—Quiet—Clean.

Quality High Speed steel hardening with the patented automatic

*Sentry Diamond Block Method of Atmospheric Control*

No Atmosphere Generators to start, adjust, maintain or clean.

Any alloy of High Speed or High Carbon High Chrome steel hardened rapidly without scale or decarburization. No specially trained or highly skilled operators required. Hardening quality consistently of the highest.

*Send sample pieces for demonstration or Write for Bulletin 1020-5A*

Sentry "Always on Duty"

The Sentry Company
FOXBORO, MASS., U. S. A.

# Q — *Which is the X-ray Film to use for this steel casting at 160 Kilovolts?*

# A — *Two films—Kodak's Type "A" and Type "K" —exposed together.*

FOR examination of this multiple thickness casting, good detail is desirable in both the ½-inch plate area and the $1\frac{3}{16}$-inch bosses.

At limited voltages, a single film would not have the latitude required. Two separate exposures could do it, but the best use of available equipment and film would be with the "two-film" technic: Kodak Industrial X-ray Film Type "A," for the plate area, and a Type "K" Film, for the bosses, sandwiched between three lead foil screens, as shown by the diagram below. This provides good detail in both thicknesses with one exposure—a good solution to problems of this kind.

Under other conditions, you might need a different Kodak X-ray Film . . . The film you select for a given job depends upon the relative emphasis you place on exposure time, contrast, and definition and the available x-ray kilovoltages or intensity of gamma radiation. But whatever your requirements, Kodak provides a film to fit them.

***Kodak provides the 4 types of film needed for Industrial Radiography***

***Kodak Industrial X-ray Film, Type A:*** Fine grain. Primarily for light alloys at lower voltages and million-volt radiography of thick steel parts.

***Kodak Industrial X-ray Film, Type F:*** Primarily for the radiography, with calcium tungstate screens, of heavy steel parts.

***Kodak Industrial X-ray Film, Type M:*** Extremely fine grain. "Made to order" for critical inspection of light alloys and, with million-volt radiography, of thinner steel parts.

***Kodak Industrial X-ray Film, Type K:*** Primarily for gamma radiography, with lead foil screens, of heavy steel parts . . . or lighter parts at low x-ray voltages.

**EASTMAN KODAK COMPANY**
**X-ray Division, Rochester 4, N. Y.**

## Personals

A. B. KINZEL, chief metallurgist of Union Carbide and Carbon Research Laboratories, has been appointed vice-president of Electro Metallurgical Co., New York City.

FRED J. WOOD, formerly Canadian manager of Jessop Steel Co., has returned to Detroit to become Michigan manager of William Jessop & Sons, Inc.

A. F. SPRANKLE, formerly manager of the Alloy Bureau, Carnegie-Illinois Steel Corp., Pittsburgh District, has been appointed metallurgical engineer in the Timken Steel and Tube Division, Canton, Ohio.

Appointments by Rustless Iron and Steel Corp.: PETER B. KLINE as manager of eastern sales; THOMAS L. MOORE as manager of western sales; S. M. GAHAGEN as West Coast representative.

H. S. SCHAUFUS, forme stainless steel metallurgist for comb Steel Division, Crucible S Co. of America, Syracuse, N. Y now chief metallurgist, Eas Stainless Steel Corp., Baltimor

FRED A. KAUFMAN, form research metallurgist for the Cr Can Co., is now a member of staff of Mellon Institute of In trial Research, Pittsburgh, as in trial fellow on the McKay Welding Fellowship.

FRED GROTTS, president Fort Pitt Steel Casting Co., has been appointed to a newly cre position as director of research metallurgy for all plants of H Porter Co., Inc. of Pittsburgh, parent company.

E. H. CARMANY has been pointed vice-president in charg eastern operations for Wyc Steel Co., with headquarters Newark, N. J.

M. M. CLARK has joined Cli Molybdenum Co. as metallurg engineer, Ohio district, with h quarters in Canton, Ohio.

MARTIN CASERIO, former m ufacturing superintendent of craft bearings, has been appoi chief metallurgist of A.C. Sp Plug Division, General Motors C

Retired: DAYTON A. GURNEY resigning as chief ordnance e neer of the Artillery Division of Ordnance Department, Army S ice Forces.

JOHN W. SANDS, with Conservation Division of the W Production Board since Jan. 1 has resumed his duties with development and research divis of the International Nickel Co., I New York.

JOHN SHEPPARD has resig as chief metallurgist of Ke Hayes Wheel Co., Detroit, to bec metallurgist and assistant p manager of Michigan Steel P essing Co., Detroit.

JOSEPH A. ZERKEL, form alloy metallurgist at the Indi Harbor plant of Youngstown S & Tube Co., Youngstown, Ohio, been appointed metallurgical e neer of the Milwaukee Forg Machine Co., Milwaukee.


*Immersed Electrode Method . . .*
**SALT BATH HEAT TREATING**

DEMPSEY FURNACES
***PRODUCING***
**FOR INDUSTRY**

Bethlehem Steel
Bohn Aluminum & Brass
Buick Motors
Ford Motor Co.
General Electric
Nash-Kelvinator
Oldsmobile
Reynolds Metals
Sperry Gyroscope
Worthington Pump and Machinery
Wright Aeronautical

***New Bulletin . . .*** **SENT ON REQUEST**

Low, medium and high temperature heat treating by the immersed electrode method, covering a range of from 400° F. to 2400° F., are all dealt with comprehensively in this helpful new bulletin by Dempsey Engineers. It explains how, with the immersed electrode principle, decarburization or carburization and surface ozidization may be eliminated, and exacting cycles achieved in extremely short heating times *without* undue shortening of container life. It tells how fast, economical production may be obtained with extremely low maintenance cost. Your copy is waiting. Ask for it.

**DEMPSEY INDUSTRIAL FURNACE CORPORATION**
**SPRINGFIELD, MASSACHUSETTS**

# "WE'D RATHER SAY *YES*"

We don't like to tell people that they'll have to wait to get a home telephone. We'd much rather say "yes" to requests for service. That's the way it always used to be.

But the needs of war still have first claim on available telephone equipment and on telephone manufacturing facilities and manpower. Delays in filling civilian orders just can't be helped.

All of us telephone people sincerely appreciate your patience and understanding in this war emergency.

**BELL TELEPHONE SYSTEM**

## Personals

ERNEST H. WYCHE, formerly in the metallurgical department of Carnegie-Illinois Steel Corp., is now research engineer with the Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

Transferred by Eaton Mfg. Co., Wilcox-Rich Division: EARL H. SHIPLEY from the Battle Creek plant to the Detroit laboratory.

O. W. LONGAN has been made superintendent and metallurgist for P. M. Payne Co., Denver.

LEONARD D. ORR, formerly metallurgist for Nash-Kelvinator Corp., Propeller Division, Lansing, Mich., is now employed by Chrysler Corp., Detroit, as resident metallurgist, Dodge Truck Plant.

LAURENCE A. WEAVER is now with Indiana Steel Products Co., Valparaiso, Ind., as metallurgist.

JOHN C. HUFFMAN has bee appointed sales manager of th Cleveland district for the Braeburn Alloy Steel Corp.

RAY E. CROSS, formerly me allurgist, Magnesium Fabricator Adrian, Mich., is now chief meta lurgist and process and develop ment engineer at Maryland Sanitar & Mfg. Co., Baltimore, Md.

GEORGE H. PERKINS has bee transferred from foreman to meta lurgical field inspector for th American Locomotive Co.

ROBERT B. SMOCK has left th Glenn L. Martin Co. and taken position as assistant engineer in jo evaluation with Western Electri Co., Point Breeze, Baltimore, Md.

THOMAS E. LEONTIS has com pleted graduate studies in the de partment of metallurgy at Carnegi Institute of Technology and is no a member of the metallurgical sta of Dow Chemical Co.

RICHARD B. KROPF has bee promoted district manager of Co perweld Steel Co.'s newly opene New England District Office i Hartford, Conn.

R. J. KICK, B.S. in Metallurg cal Engineering, Missouri School Mines, is now working in the re search laboratories of Morain Products Division of General Mo tors Corp.

DAN A. SUTCH, formerl foundry superintendent, Vulca Iron Works, Wilkes-Barre, Pa., i now metallurgist with Wickwir Spencer Steel Co., Buffalo.

CRUZAN ALEXANDER, formerl research associate at the Universit of Michigan, is now with the Phil lips Petroleum Co., Bartlesville Okla., as an attorney in the paten department.

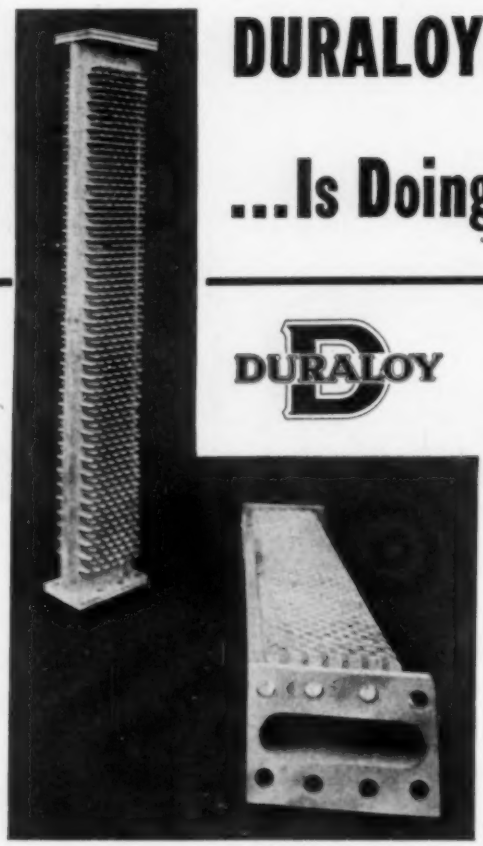
D. V. HAMILTON, formerl superintendent of electric furnace at Canadian Tube & Steel Product Montreal, is now plant manage Chromium Mining & Smeltin Corp., Sault St. Marie, Ont.

ARTHUR M. MORGAN, vice-pre ident in charge of sales of Latrob Electric Steel Co., Latrobe, Pa., ha been elected a director of the com pany.


DIFFICULT CASTINGS?

DURALOY Can Do It...

...Is Doing It!



DURALOY

For high alloy castings, DURALOY is a sure bet. With accrued experience dating back to the beginning of the chrome-iron and chrome-nickel alloy industry in this country . . . with skilled personnel and superb casting, annealing, machining, and testing facilities, DURALOY stands ready to take care of your high alloy casting problem.

11-DU-2

THE DURALOY COMPANY

*Office and Plant:* Scottdale, Pa. • *Eastern Office:* 12 East 41st Street, New York 17, N. Y.

Los Angeles & San Francisco: KILSBY & GRAHAM — Chicago & Detroit: F. B. CORNELL & ASSOCIATES — Scranton, Pa.: COFFIN & SMITH

METAL GOODS CORP: St. Louis • Houston • Dallas • Tulsa • New Orleans • Kansas City

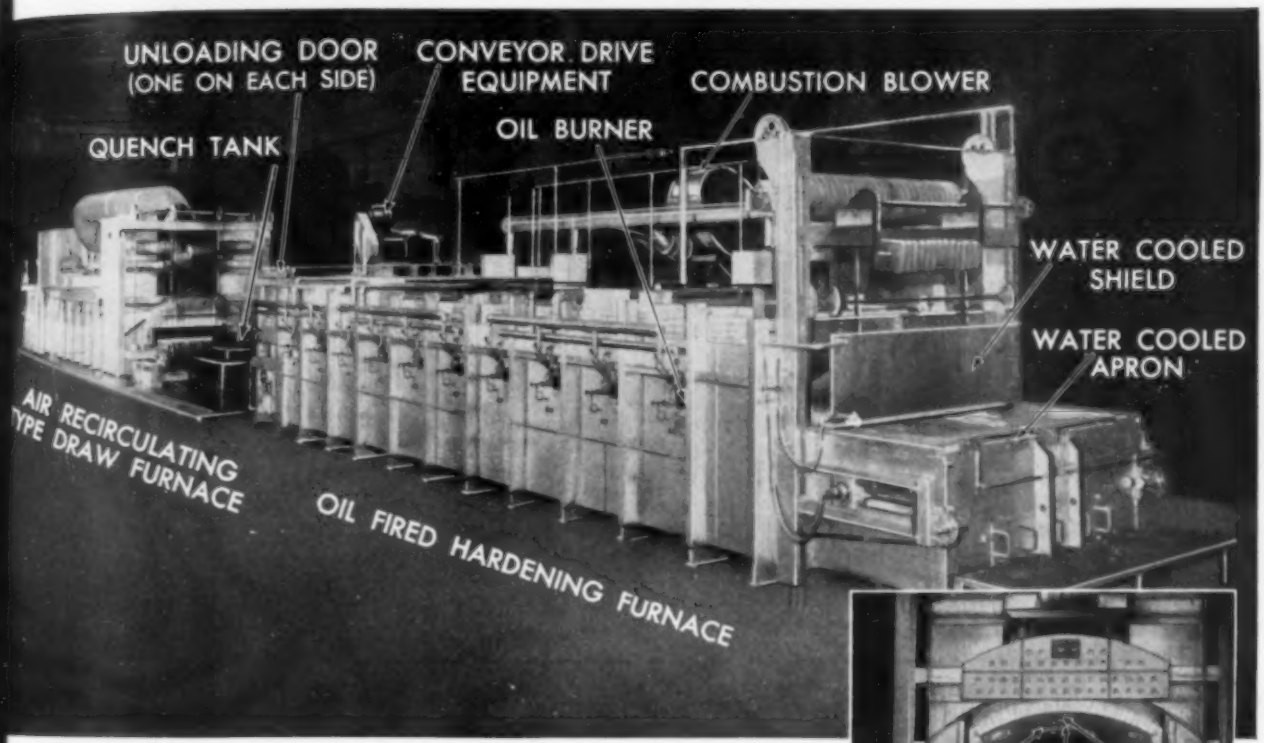
# STEWART

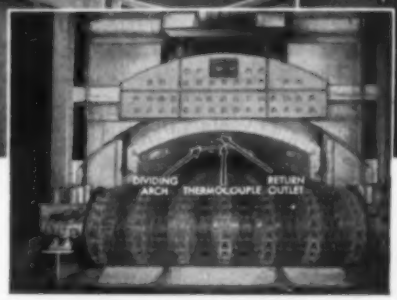
THE BEST INDUSTRIAL FURNACES MADE

No. 54 OF A SERIES of Typical Installations

## For HEAT TREATING LEAF SPRINGS

### at the Standard Steel Spring Company, New Castle, Pa.



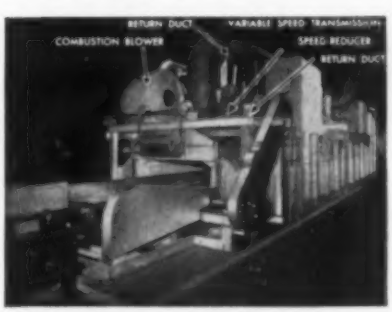




*Interior of Stewart Draw Furnace from the charging end showing the conveyor belt.*

The problem of getting uniformity in heat treating leaf springs is difficult, due to the size of the spring and the great variation in length of the leaves in a single spring. A considerable amount of the possible variation is avoided by running all the leaves of each spring through the heat treating process at the same time. However, only an unusually well designed and properly operated furnace can be depended upon to make a six-foot leaf uniform from end to end and to give a one-foot leaf the same physical qualities as a six-foot leaf. The furnace must maintain the temperature within very close, predetermined limits and provide absolutely uniform conditions throughout.

Standard Steel Spring Company, for many years prominent in the heat treating of metals, and a prior user of Stewart Furnaces, has recently added to its furnace equipment by purchasing Stewart Hardening and Draw Furnaces for two plants to meet its increased production schedules for leaf springs.

This installation is typical of the industrial furnaces Stewart engineers are building every day, both large types to meet the specified requirements of manufacturers all over the continent, and a complete line of standard types.




*Discharge end of the Stewart Recirculating Draw Furnace showing Conveyor Belt drive through speed reducer and variable speed transmission.*

**STEWART INDUSTRIAL FURNACE DIVISION of CHICAGO FLEXIBLE SHAFT CO.**

*Main Office:* **5600 W. Roosevelt Road, Chicago 50, Ill.** — *Canada Factory:* **(FLEXIBLE SHAFT CO., LTD.) 321 Weston Rd., Se., Toronto 9**

*A letter, wire or 'phone call will promptly bring you information and details on STEWART furnaces, either units for which plans are now ready or units especially designed to meet your needs. Or, if you prefer, a STEWART engineer will be glad to call and discuss your heat treating problems with you.*

# *WHAT'S NEW*

## IN MANUFACTURER'S LITERATURE

### METAL WORKING • FABRICATION

*Powdered metal presses.* Kux Machine Co. Bulletin 1.

*Horizontal extrusion presses.* Hydropress, Inc. Bulletin 3.

*36-page pictorial story* of the Cecostamp. Chambersburg Engineering Co. Bulletin 4.

*Cutting Oils.* Cities Service Oil Co. Bulletin 5.

*Presses* for Powder Metallurgy. F. J. Stokes Machine Co. Bulletin 7.

*Information and data* on straightening press. Anderson Bros. Mfg. Co. Bulletin 10.

*Mounted wheels,* Handee and Hi-Power tools. Chicago Wheel & Mfg. Co. Bulletin 21.

*Catalog 44* is a new and enlarged reference to Kennametal tools and products. Graphically indexed, this 48-page catalog covers many metal working features. Kennametal, Inc. Bulletin 541.

*Forging presses.* Ajax Mfg. Co. Bulletin 2.

*Air tools in steel mills* and foundries are pictured in new booklet by Ingersoll-Rand. Bulletin 255.

*Practical data sheet* describes cutting and grinding compound. Diversey Corp. Bulletin 447.

*Surface coated abrasive belts.* Minnesota Mining & Mfg. Co. Bulletin 12.

*Complete and valuable study* of "Machining of Metals", including chip formation, is offered by National Refining Co. Bulletin 335.

*Safe-T tongs* and their use in materials handling are described in new booklet by Heppenstall Co. Bulletin 434.

*This company has issued* two new booklets showing new price lists for sintered carbides. Firth-Sterling Steel Co. Bulletin 486.

*Attractive 16-page booklet* describes the new "MX" grinding tools, citing many features and applications. Carborundum Co. Bulletin 518.

*Struthers Wells Corportion's* T... gent Bender and its ability to e... bend sheet metal in the light... gauges is described in illustrat... 8-page leaflet. Bulletin 520.

*8-page general catalog* outlines ... hard facing alloys and overlay m... als of this company, with ma... illustrations and typical applicatio... Wall-Colmonoy Corp. Bulletin 4...

*Properties* and uses of cutting o... Gulf Oil Corp. Bulletin 8.

*Attractive new bulletin* describ... the Spencer Turbine Co.'s Sump-V... a new portable vacuum produc... which is said to clean machine sur... tanks in 2 to 10 min. Bulletin 4...

*Pictorial 6-page leaflet* describ... use of Norton Co.'s resinoid gri... ing wheels on snagging jobs. Bul... tin 550.

*Steam drop hammers* up to 75,0... pounds are described in book... offered by Erie Foundry Co. Bul... tin 562.

*DoAll Zephyr* cutting machi... and its many advantages for met... and other materials is described ... new illustrated literature. Con... nental Machines, Inc. Bulletin 5...

**Use Handy Coupon Below for Ordering Helpful Literature.**

**Other Manufacturers' Literature Lis... on pages 1122, 1124, 1126, 1128, 1130, 11... 1134, 1136, 1138, 1140, 1142, 1144, 11... 1147, 1148, 1150, 1152, 1154 and 1156.**

**Metal Progress 7301 Euclid Ave., Cleveland 3, Ohio** November, 19...

**Send me the Literature I have indicated below.**

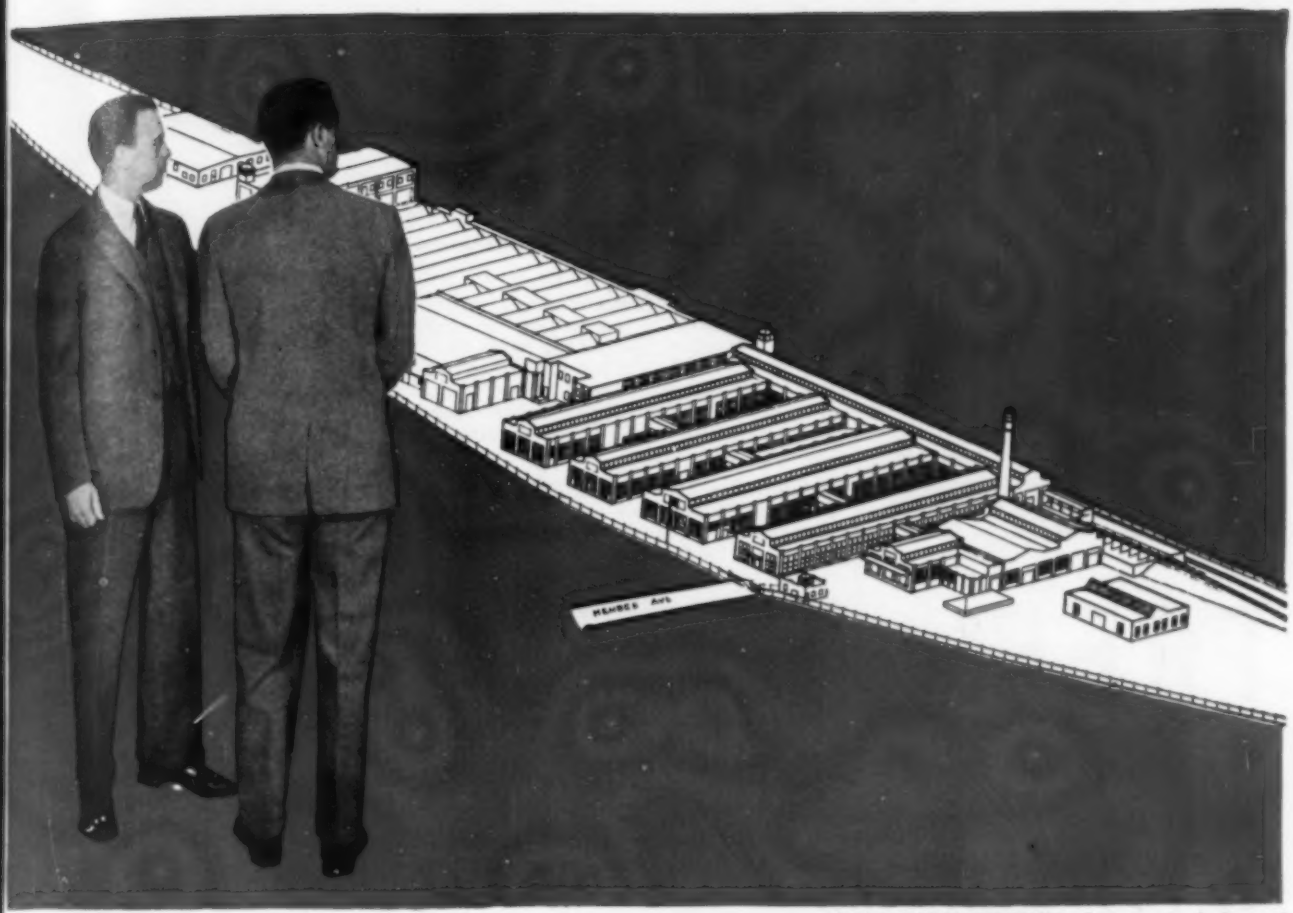
**Name** .....**Title** .....

**Company** .....**Address** .....

(Students—please write direct to manufacturers.)

**Check or circle the numbers referring to literature described on these 20 pages.**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 59 | 107 | 148 | 182 | 258 | 331 | 372 | 445 | 473 | 508 | 534 | 558 | 580 | 607 |
| 2 | 62 | 109 | 149 | 185 | 271 | 333 | 380 | 446 | 477 | 511 | 535 | 560 | 581 | 608 |
| 3 | 65 | 114 | 150 | 186 | 281 | 335 | 383 | 447 | 478 | 512 | 536 | 562 | 583 | 609 |
| 4 | 66 | 115 | 152 | 189 | 284 | 337 | 385 | 448 | 481 | 513 | 537 | 563 | 584 | 610 |
| 5 | 70 | 116 | 154 | 190 | 288 | 338 | 388 | 449 | 483 | 515 | 538 | 564 | 585 | 611 |
| 7 | 71 | 117 | 155 | 192 | 292 | 339 | 390 | 450 | 484 | 516 | 539 | 565 | 589 | 612 |
| 8 | 72 | 118 | 156 | 193 | 296 | 343 | 399 | 452 | 486 | 517 | 540 | 566 | 590 | 613 |
| 10 | 79 | 119 | 158 | 197 | 297 | 345 | 404 | 453 | 487 | 518 | 541 | 567 | 591 | 614 |
| 12 | 82 | 123 | 161 | 199 | 305 | 347 | 406 | 454 | 491 | 520 | 542 | 568 | 593 | 615 |
| 21 | 85 | 128 | 162 | 200 | 307 | 353 | 407 | 455 | 492 | 521 | 543 | 569 | 594 | 616 |
| 25 | 86 | 132 | 164 | 203 | 314 | 354 | 409 | 457 | 493 | 522 | 544 | 570 | 595 | |
| 26 | 89 | 134 | 167 | 204 | 318 | 359 | 410 | 458 | 494 | 525 | 545 | 571 | 597 | |
| 33 | 93 | 135 | 170 | 206 | 319 | 361 | 420 | 459 | 495 | 526 | 549 | 572 | 598 | |
| 35 | 94 | 137 | 171 | 208 | 322 | 362 | 424 | 461 | 497 | 527 | 550 | 573 | 599 | |
| 40 | 96 | 139 | 172 | 210 | 323 | 363 | 428 | 462 | 499 | 528 | 551 | 574 | 600 | |
| 41 | 97 | 141 | 173 | 212 | 324 | 364 | 433 | 463 | 500 | 529 | 552 | 575 | 602 | |
| 42 | 98 | 142 | 176 | 213 | 325 | 366 | 434 | 465 | 501 | 530 | 553 | 576 | 603 | |
| 45 | 102 | 143 | 177 | 215 | 327 | 367 | 436 | 470 | 502 | 531 | 554 | 577 | 604 | |
| 51 | 103 | 146 | 179 | 246 | 328 | 368 | 437 | 471 | 504 | 532 | 556 | 578 | 605 | |
| 56 | 106 | 147 | 180 | 255 | 329 | 369 | 440 | 472 | 506 | 533 | 557 | 579 | 606 | |



**192,000 SQUARE FEET** of conveniently located space. In this modern, streamlined Reynolds plant, aluminum produced in other Reynolds plants is cast into parts for today's warplane engines.

# REYNOLDS ALUMINUM:

## ...now a new service, in a great new plant

THROUGHOUT the aircraft industry, Reynolds is known as the leading producer of sheet aluminum, fabricated aluminum parts and aluminum forgings for warplane production.

Now Reynolds rounds out the scope of its services with the addition of complete facilities for aluminum castings.

This latest expansion came in answer to a request for help. Aluminum alloy parts, high in physical properties, were needed for engines to power warplanes.

Conventional sandmold casting was tried ... but the real solution was found to be in the use of the permanent mold process—a tricky and difficult operation.

Reynolds found that superior quality alloy castings of this type were being produced in a plant in England. The chief technician was sought out and borrowed. Reynolds now had the type of casting and the man — needed still, however, the right machines.

From this point on things moved faster and faster!

***On May 15, 1944,*** a pilot plant was set up.

***Six weeks later***—the first casting was produced, a casting judged perfect by exacting aircraft engine builders.

***Six months later***—and Reynolds is producing castings on a permanent mold line in a modern plant at Springfield, Mass.

But the story does not end here!

### A PROMISE FOR TOMORROW!

After the war the output of this plant can be increased five-fold. Five times as many people can be employed in casting parts for peacetime automobiles, refrigerators, washing machines, vacuum cleaners, electric irons, and hundreds of other products.

Whatever your problem today—or tomorrow—remember, if they concern aluminum—sheets, fabricated parts, forgings or castings—you'll find Reynolds resources, equipment and skill ready to help you! Reynolds Metals Company, General Offices: Richmond 19, Virginia; Aluminum Division, Louisville 1, Kentucky; Springfield, Mass. Sales Offices in 25 principal cities.

**GEAR CASE**, made from aluminum alloy, cast from permanent molds at the Reynolds Metals Company plant, Springfield, Mass.

# FREE!

**THIS 24" x 32" WALL CHART GIVES ROCKWELL, BRINELL, SCLERO, VICKERS HARDNESS AND TENSILE STRENGTH CONVERSIONS...**

● If you are a production executive whose responsibility includes the hardness testing of metals, you will certainly want one of these new charts for your office, shop, or laboratory. Handsome in appearance, printed in three colors, with the very minimum of advertising, it will prove its value every hour of every day. Type is large, easily read at a distance of several feet, yet the chart itself is only 24" wide and 32" high—about the size of a calendar.

Although a chart like this is relatively expensive to produce, and the quantity is rigidly limited, a copy is yours — free for the asking — if you request it on your letterhead.

Write Dept. MP, CLARK INSTRUMENT INC., 10200 Ford Road, Dearborn, Michigan.

CLARK

TOMORROW'S ACCURACY TODAY

**HARDNESS TESTER**

FOR "ROCKWELL" TESTING

# *WHAT'S NEW*

## IN MANUFACTURERS' LITERATURE

*Interesting information* on precision grinding is contained in this 12-page booklet "Grinding With Oil". Use of straight oils for thread grinding, gear grinding, and other precision grinding operations is discussed and well illustrated. D. A. Stuart Oil Co. Bulletin 581.

*Facilities* of Peerless Tool & Engineering Co. for tool building and tool design are described in literature available in Bulletin 597.

### FERROUS METALS

*A new heat treating guide* which should prove a great convenience and time saver has just been completed by Carpenter Steel Co. In easy-to-use form this slide chart gives complete information on heat treatment of all Carpenter matched tool steels. Bulletin 604.

*Spindle speed calculator* is handy chart to figure machining rates on bar steels. Bliss & Laughlin, Inc. Bulletin 333.

*Speed Case and Speed Treat* cold finished bars are described in detail in a new profusely illustrated 24-page bulletin issued by the Monarch Steel Co. Bulletin 551.

*136-page, pocket-size* handbook of special steels — newly revised and reprinted—describes properties, uses and best methods of handling, treatment, etc., of tool, stainless and other alloy steels. Allegheny Ludlum Steel Corp. Bulletin 575.

*Properties* of Frequently Used Carbon and Alloys Steels is title of big, new booklet issued by Bethlehem Steel Co. Bulletin 580.

*Republic Steel Corp.'s* second edition of National Emergency Steels tells you all about these new steels. Bulletin 345.

*New 46-page booklet*, "Wear, A Discussion of the Mechanism of Wear Phenomena and Influencing Factors", is said to be the first book in English on the subject of wear. Nitralloy Corp. Bulletin 539.

*Page after page* of useful technical data and reference tables on tool steels. Latrobe Electric Steel Co. Bulletin 367.

*Steel Data Sheets*. Wheelock, Lovejoy & Co. Bulletin 25.

*Molybdenum wrought steels*. Molybdenum Corp. of America. Bulletin 26.

*Chemical analyses*, shapes and sizes of Joslyn stainless steel products. Joslyn Mfg. and Supply Co. Bulletin 297.

*Enameling iron sheets*. Inland Steel Co. Bulletin 33.

*Loose-leaf reference book* on molybdenum steels. Climax Molybdenum Co. Bulletin 35.

*Aircraft Alloy Steels*. Joseph T. Ryerson & Son, Inc. Bulletin 40.

*Attractive new catalog* describes the line of steel offered by Peninsular Steel Co. Bulletin 337.

*New Catalog C* makes it easy to get International Nickel Co. literature, as it presents brief description and index to a wide variety of booklets. Bulletin 305.

*"Graphitic Booklet"* gives complete information on new, free-machining, long-wearing steel. Steel & Tube Div., Timken Roller Bearing Co. Bulletin 307.

*HWD hot work die steel* and Sterling stainless steels are described in four new leaflets by Firth-Sterling Steel Co. Bulletin 323.

*New booklet* gives full information on N-A-X high tensile and N-A-X 9100 Series of alloy steels. Great Lakes Steel Corp. Bulletin 328.

*Fitzsimons Co.* issues interesting leaflet on speed case and speed treat steels. Bulletin 452.

*84-page tool and die* steel handbook just issued by Ziv Steel & Wire Co. is a helpful guide to selection, treatment and use of these important steels. Bulletin 440.

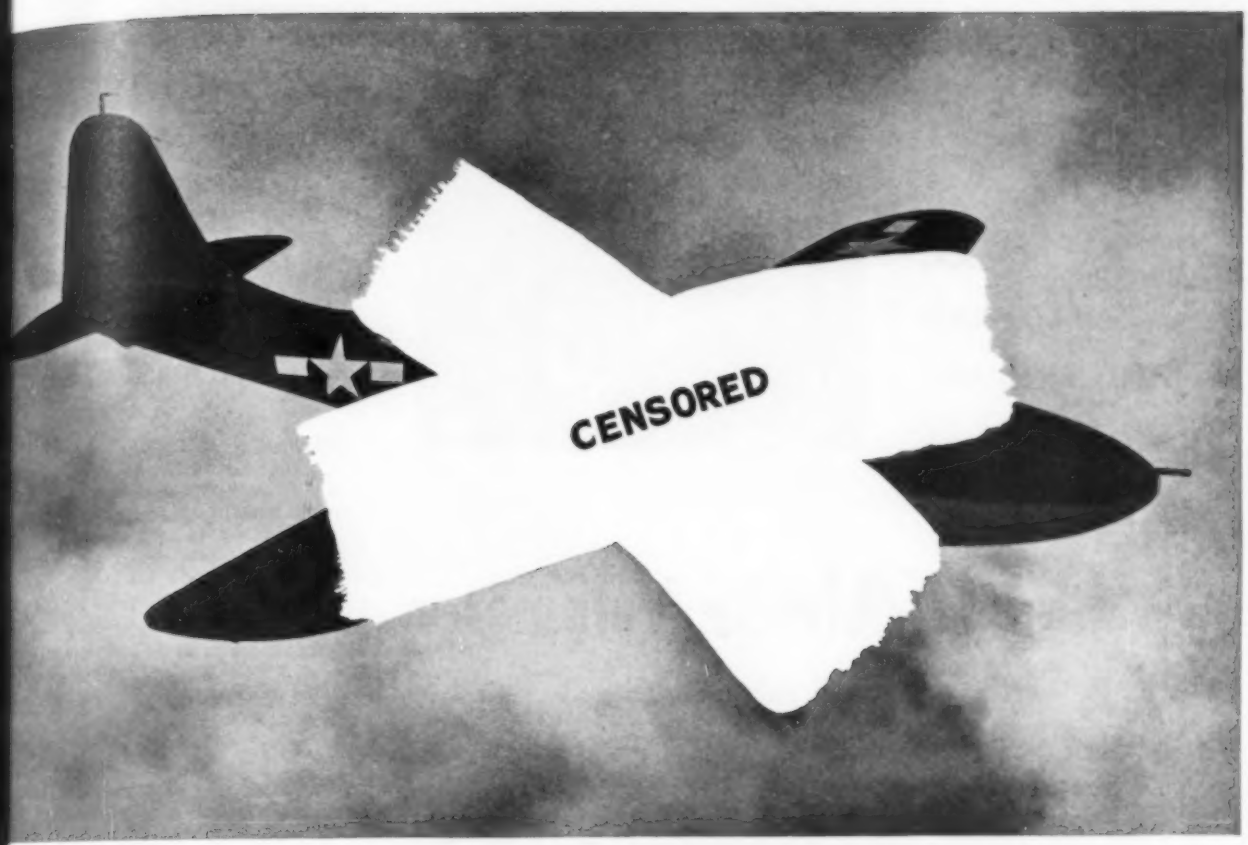
*Kinite alloy tool steel bar stock*. H. Boker & Co., Inc. Bulletin 258.

*SKF Steels, Inc.*, has issued a stock list of high carbon-high chrome seamless steel tubing and round bars, available for immediate delivery. Bulletin 566.

*Latest data chart*, Section D, No. 1, shows government "specs" for alloy steels and corresponding commercial designations. Peter A. Frasse & Co., Inc. Bulletin 533.

**Use Handy Coupon on Page 1120 for Ordering Helpful Literature.**

**Other Manufacturers' Literature Listed on pages 1120, 1124, 1126, 1128, 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1147, 1148, 1150, 1152, 1154 and 1156.**




# THE *Rocket Plane* TAKES TO THE SKIES

years designers of high-speed aircraft have amed of the day when planes would shed their ops" and be driven, instead, by jet propulsion.

oday, at Bell Aircraft, the rocket plane is no ger a dream but a reality. It has emerged from the wing-board stage and is now in production. A e that flies at such speeds and altitudes, and with startling maneuverability, that its test flights sed engineers to say that the jet plane had opened w chapter in aviation history.

echanical features of Bell's new "rocket ship" naturally shrouded in wartime secrecy. It can said, however, that many of the parts made by —and many of the parts supplied by other manu- urers—are of Bethlehem alloy steels. As a mat- of fact, through the years of its growth to its ent high position, the Bell organization has made hlehem Steel one of its chief sources of supply.

Alloy steels are playing a vital part in the development of newer and faster planes, and in hundreds of other products essential to the war effort. A tremendous amount of research on wartime steels has been done by Bethlehem metallurgists—research that has included the most exhaustive laboratory tests. If you have an alloy-steel problem involving analyses, properties, heat treating, or applications, the data resulting from this research are at your service. Write Bethlehem Steel Company, Bethlehem, Pa.

BETHLEHEM STEEL COMPANY, Bethlehem, Pa.
Bethlehem Steel Export Corporation, New York City

★ ★ BETHLEHEM STEEL ★ ★

CHECK
BLOWERS
AND EXHAUST
SYSTEMS
*Instantly*

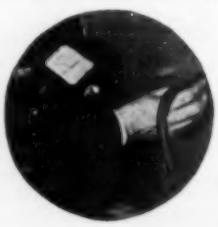
# with the Alnor Velometer

This instantaneous direct reading air velocity meter measures air speed in feet per minute. There are no calculations, no timing, no conversion tables; its use is so simple that anyone can take accurate measurements with the Velometer. Extension jets permit correct readings in many locations that would be difficult or impossible to reach with other means of measurement.

Keep exhaust equipment working efficiently by regular checks for draft, leaks, blower operations, etc., with the Alnor Velometer. You can get accurate information on performance with a few minutes' inspection at regular intervals.

The Velometer is made in several standard ranges from 20 fpm to 6000 fpm and up to 3 inches static or total pressure. Special ranges available as low as 10 fpm and up to 25000 fpm velocity and 20 inches pressure. Write for Velometer bulletins.

Velometer used for positive static pressure readings



**ILLINOIS TESTING LABORATORIES, INC.**
420 North La Salle Street
Chicago 10, Illinois


## *WHAT'S NEW*

**IN MANUFACTURERS' LITERATU**

*32-page booklet* which pictoria and textually amounts to a scienti treatise on two carbon steels — Spe Case and Speed Treat — has been sued by W. J. Holliday & Co. Bul tin 450.

*Molybdenum-Tungsten high sp* steels marketed under the gene trade name Mo-Max are discuss comprehensively in 52–page book J. V. Emmons, metallurgist for Cleveland Twist Drill Co. Bulle 497.

*Important practical* heat treati information about stainless ste has just been issued by Rustless Ir and Steel Corp. Bulletin 563.

*New 38-page handbook* for signers of stainless steel equipm gives valuable information for acc rately proportioning stronger ligh parts. It is said to be the first ti such detailed values for commerc stainless, both above and below yield point have been compil American Rolling Mill Co. Bulle 553.

*Facts on Beryllium Copper*, incl ing composition, forms availab applications and extensive additio information are presented in t new 16-page booklet by the Riv side Metal Co. Bulletin 511.

### NON-FERROUS METALS

*36-page booklet* outlines ve briefly the description of vario ASTM, AMS, SAE and governm specifications for nonferrous str tural materials. Central Steel & W Company. Bulletin 613.

*Publication* of a new bulletin, No Ferrous Forgings Digest has be started by the Brass Forging As It will be issued periodically. Bul tin 615.

*80-page pipe and tube* bendi handbook has been issued by Copp & Brass Research Assn. Bulletin 3


Use Handy Coupon on Page 1120 for Ordering Helpful Literature.

Other Manufacturers' Literature Lists on pages 1120, 1122, 1126, 1128, 1130, 11 1134, 1136, 1138, 1140, 1142, 1144, 11 1147, 1148, 1150, 1152, 1154 and 1156.

**Impressor**

**ARDNESS TESTER**
**r SOFT METALS *and* PLASTICS**

ht, small, handy, quick, convenient to , and easy to carry. Simply press the ng-loaded indentor point against the face, and the dial immediately shows the tive hardness of the material. Widely d in aircraft and other war goods plants checking aluminum, aluminum alloys, other non-ferrous metals, as well as tics, hard rubber, and the like. Write complete information and prices.

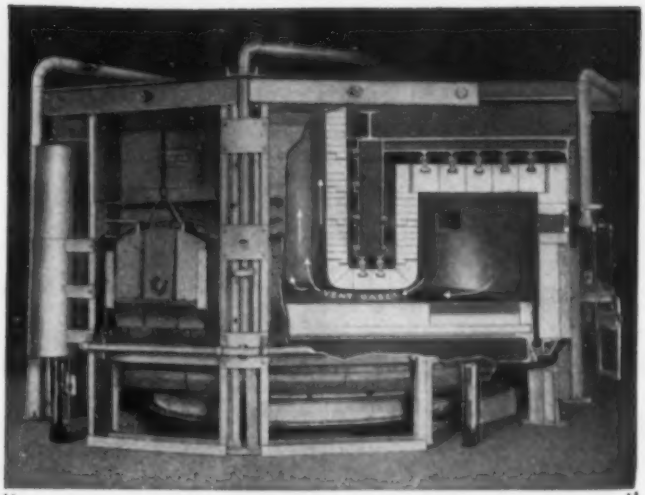
**BARBER-COLMAN COMPANY**
ROCKFORD • ILLINOIS

## Metallurgist

Our Long Island metallurgical laboratory desires a capable research metallurgist with several years' experience on copper and copper alloys. In addition to research and development work, the position will require the ability to handle all copper problems for our various plants.

This position should prove attractive to a young man interested in long-range growth prospects.

Please describe fully your experience on copper problems, and give particulars of age, education, and salary desired. Early interviews in New York City will be arranged with qualified applicants. Box MP50



**JOHNSTON** OIL OR GAS FIRED

**Rotating Hearth FORGING FURNACES**

Among the outstanding advantages of these furnaces is the special JOHNSTON roof construction with

**NEW DEPRESSED CENTER VENT Feature**

— as shown above (Patent allowed) — which permits escape of the hot gases from hearth level. This results in:—

**high efficiency, —fast heating, —25% fuel saving.**

The furnace roof is suspended by a sturdy steel frame and all tile are interlocked and sealed with cement. The furnace chamber is in the form of a ring, and can be zoned for better control over the entire heating range.

**Furnace Complete with:—**

smooth friction drive for table, Automatic Control and Hydraulic Door Hoisting Mechanism.

*Further details on request*

**ENGINEERS & MANUFACTURERS**
of Furnaces, Burners, Blowers, Controllers, Forges, Torches, Ladle Heaters, etc.
Sales Representatives in Principal Cities

SAFETY THE JOHNSTON LINE DEPENDABILITY

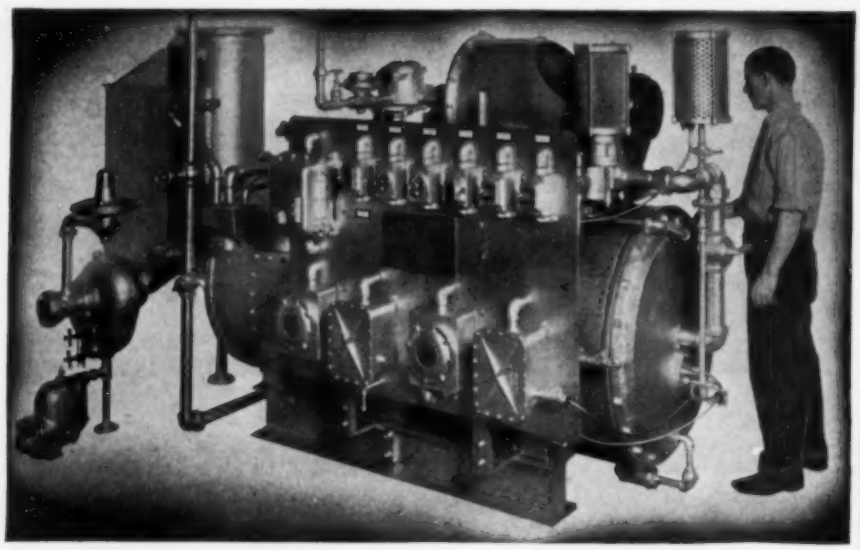
**JOHNSTON MANUFACTURING COMPANY**
2825 EAST HENNEPIN AVENUE · MINNEAPOLIS 13, MINNESOTA

# *WHAT'S NEW*

## IN MANUFACTURERS' LITERATURE

*Copper Alloys.* American Brass Co. Bulletin 45.

*Platinum Metal Catalysts.* Baker & Co., Inc. Bulletin 41.

**For Purging—**

**For Blanketing—**

**For Processing—**

Specify the Kemp Inert Gas Producer where processing conditions or requirements call for inert or protective atmospheres.

Kemp Inert Gas Generators are available in capacities ranging from 1,000 to 100,000 cubic feet per hour, may be furnished for semi-automatic or automatic operation. Safety features include electric ignition, safety pilot, soft heads, fire checks, and automatic shutdown in the event of

(a) burner outage (b) cooling water failure, or (c) fuel gas supply failure.

The inert atmosphere is delivered at a temperature of not more than 15° F. above the inlet temperature of cooling water with a corresponding dewpoint. When dryer gases are required, low dewpoints may be obtained by selection of suitable auxiliary drying equipment. Write for engineering data, recommendations, and quotations.

**Ask for Bulletin 901.3**

**OTHER KEMP PRODUCTS**

Adsorptive Dryers for Air and Gas
Atmos-Gas Generators for Special Atmospheres
The Industrial Carburetor for premixing gases
Immersion Heaters
Submerged Combustion Burners
A complete line of Industrial Burners, and Fire Checks

Address The C. M. Kemp Mfg. Co. 405 E. Oliver St., Baltimore-2, Maryland

**KEMP of BALTIMORE**


*6th edition of Revere Weights* Data Handbook. Revere Copper Brass, Inc. Bulletin 296.

*Die casting equipment.* Le Phoenix, Inc. Bulletin 42.

*This "Aluminum Imagineer* Notebook" presents 12 import economic advantages of alumi and illustrates numerous exam of things which have been im neered into aluminum actualit Aluminum Co. of America. Bull 472.

*Rare metals,* alloys and ores. Fo Mineral Co. Bulletin 56.

*Two new Ampco Metal data sh* discuss forging Ampco to impr physical characteristics and use Ampco for non-scratching ed gers. Bulletin 314.

*"Designing with Magnesium"* is tle of new book offered by Ameri Magnesium Corp. Bulletin 433.

*Printed information on Lithium* interest to nonferrous and physi metallurgists is available from L aloys Corp. Bulletin 532.

*Two new bulletins* present m interesting facts on aluminum ing and aluminum wire, rod and Reynolds Metals Co. Bulletin 5

*Red-X Aluminum Alloys,* produ by the largest single producer Commercial Aluminum and Mag sium Alloys, the National Smelt Co. are described, applications st ied, in this 16-page file folder. letin 499.

*Dowmetal data book.* Dow Che cal Co. Bulletin 51.

*"Some Considerations* in Mak Test Bars" is the title of an inter ing booklet by Federated Metals D American Smelting and Refining Bulletin 529.

*32-page booklet,* "Revere Mag sium Alloys and the Light Me Era", is now coming off the pr with basic facts about magnesi plus detailed technical data on p ical, mechanical and working ch acteristics of the Revere Allo Revere Copper and Brass, Inc. letin 579.


Use Handy Coupon on Page 1120 for Ordering Helpful Literature.

Other Manufacturers' Literature Li on pages 1120, 1122, 1124, 1128, 1130, 1134, 1136, 1138, 1140, 1142, 1144, 1147, 1148, 1150, 1152, 1154 and 115

Q-ALLOYS THE QUALITY NAMES IN ALLOY FOR HEAT CORROSION ABRASION X-ite

# WE CELEBRATED Q-ALLOYS 25th ANNIVERSARY IN CLEVELAND AT THE METAL SHOW!!
# TO OUR FRIENDS OF ASM WE ARE DEEPLY GRATEFUL!

FOR Twenty-five Years Q-Alloys have been the largest Alloy Exhibitor, and the only continuous alloy exhibitor.

DURING this time General Alloys has exhibited more castings at A.S.M. shows and carried more advertising in A.S.M. publications than all competitors combined. This is only fair return, for *we have grown up with A.S.M.*, whose members have *made our success possible.*

WE ARE deeply gratified by the hundreds of congratulatory letters received and by the good wishes of our friends who called at our booth to extend them.

WE ARE happy that we chose American Metallurgy and Heat Treating as the field in which to pioneer our development of Metallurgical and Mechanical Engineering for high temperatures. No faster moving technology and no more loyal, intelligent, and dynamic group of men exists on earth.

THE greatest testimony to your achievement is in the success of Allied Arms.

I AM proud that this first Quarter Century comes on my forty-fifth birthday and I want to spend what life is granted me in the same company of friends and co-workers.

A SCROLL of commemoration signed by all members of the G.A. Team — a Gold Pen and Pencil set from them and a Silver Q-anniversary badge made by Walter Coley—Vice President of Leeds & Northrup Company, who has been an inspiration to me—among my gifts, are my proudest possessions.

AS WE burned a candle for each year and shared our cake with all, we gave a toast:

"To the Finest Fighting Men on Earth, America's!

To Our Country—we're proud to work *for* her!

To you—Men of A.S.M.! We're proud to work *with* you."

**J. E. Donnellan, E. E. Whiteside, Alfred Sampler, H. G. Chase, H. H. Harris, Ben Bittner, Peter Paige, Roger Sutton, Roy Lynd, L. L. Lindsey (there are many others equally of G.A. who could not get in the picture).**

We can state with pride — believe it or not — that no General Alloys Wartime Product has been metallurgically substandard for its analysis.

*We pledge sincerely* —

We'll continue to serve you with the best Engineering our mentality permits — and with the best alloy our hands can make.

FOR A QUARTER OF A CENTURY

THE FOOTSTEPS OF GENERAL ALLOYS MARK THE PATH OF AN INDUSTRY

GA X-ITE GA Q-ALLOYS GA X-ITE GA Q-ALLOYS

# *WHAT'S NEW*

## IN MANUFACTURERS' LITERATURE

### WELDING

*New method for increasing* speed of welding mild steel called "Fleet-Welding" is described in new 48-page booklet issued by the Lincoln Electric Co. Bulletin 571.

*This new chart* gives weld metal chemical composition, heat treatment specifications and identifying grade information on Arcos Corp.'s stainless and alloys electrodes. Bulletin 572.

*Bulletin GEA-4220,* well-illustrated, describes features of new current regulating compensator for resistance welding. General Electric Co. Bulletin 576.

*"Things To Know About Welding* Stainless Steel" is title of new booklet that answers many welding questions. The McKay Co. Bulletin 544.

*Welding Stainless.* Page Steel & Wire Div., American Chain & Cable Co., Inc. Bulletin 59.

*40-page catalog* reviews the progress and many applications of low temperature welding. Eutectic Welding Alloys Co. Bulletin 471.

*Oxy-acetylene welding* and cutting. Linde Air Products Co. Bulletin 62.

*Welding and brazing* of aluminum, a new data book issued by Aluminum Co. of America. Bulletin 66.

*Data book facts* on spot, seam and flash welding ferrous and non-ferrous metals and alloys. P. R. Mallory & Co., Inc. Bulletin 65.

*Nu-Braze No. 4,* an improved silver brazing alloy. Sherman & Co. Bulletin 288.

*Two new hard-facing alloys* furnished as welding rods for application by Oxy-Acetylene process are described by the Stoody Co. in Bulletin 325.

*Comparable arc welding elecrodes* for stainless are shown in chart issued by Alloy Rods Co. Bulletin 353.

*New Phos-Copper booklet* explains ways to braze, design and applications. Westinghouse. Bulletin 455.

*32-page booklet presents* numerous experience reports from large users of arc welding. General Electric Co. Bulletin 513.

*Air Reduction Sales Co.* offers 20-page revised price list, "Gas and Electric Welding Supplies and Accessories". Bulletin 512.

*Bulletin No. 14,* "How To Repair Broken Cutting Tools With Easy-Flo", is filled with practical, instructional copy, profusely illustrated. Handy & Harman. Bulletin 506.

*Pocket-sized,* slide-type guide showing proper tip sizes, gas pressures, and other data required for machine gas-cutting steel is offered by Air Reduction. Bulletin 527.

*16-page booklet* illustrates the design and construction features of certain types of Victor single and two-stage reduction regulators employed in the welding industry. Victor Equipment Co. Bulletin 552.

*End-welding* with Nelson studs i less than ½ second is described catalog and price list issued by Nelson Specialty Welding Equipme Corp. Bulletin 565.

### TESTING & INSPECTION

*6-page leaflet* describes the Leit Blosjo carbon meter for determini the carbon content of samples ch cast from molten steel. E. Leitz, In Bulletin 603.

*"Faxfilm",* a new, economica quick method of inspecting surfac finishes through enlarged Thre Dimensional Replica, is describe and illustrated in an interestin 4-page leaflet by Rex D. McDi Bulletin 602.

*New Burrell Shaker* for gener laboratory use is described in ne catalog issued by Burrell Technic Supply Co. Bulletin 543.

*Universal testing machines* an typical uses. Riehle Testing Machin Div., American Machine and Metal Inc. Bulletin 86.

*The Bristol-Rockwell* dilatomet and its use is described in th leaflet by The Bristol Co. Bulleti 465.

*Metallurgical polishing equipme* offered by Precision Scientific Cor is described in illustrated bookle Bulletin 359.

*Various methods* and specific ap plications of the measurement of cas depth are described in illustrate pamphlet offered by Allen B. DuMon Laboratories, Inc. Bulletin 339.

Use Handy Coupon on Page 1120 for Ordering Helpful Literature.

Other Manufacturers' Literature Listed on pages 1120, 1122, 1124, 1126, 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1147, 1148, 1150, 1152, 1154 and 1156.

Stuart's Thred Kut SOLVOL "SUPER-KOOL" CODOL

*Begin with the finest cutting Fluids...*

**THEN APPLY THEM PROPERLY . . .**

● Anything less than the best cutting fluids available is a handicap to your production. Equally important is *proper application.* Stuart Oil Products and Stuart Oil Engineering will give all the advantages it is possible to get from cutting fluids.

*For All Cutting Fluid Problems*

**D. A. STUART OIL CO.**

Chicago, U. S. A. • LIMITED • Est. 1865

*Warehouses in Principal Metal Working Centers*

*One purpose . . .*

# the IMPROVEMENT of Metals

*Bracket Type Forging in which a high strength-to-weight ratio is obtained by forging in a set of locked, closed impression dies which form this part to close tolerances.*

# by Forging

Close temperature and processing control is a vital factor in developing the maximum metal quality in a forging of this shape. A forging of this shape requires sound die design and a high degree of forging skill to obtain the proper distribution of metal and grain flow throughout, particularly in the lighter sectional thicknesses. This forging must stand up under severe vibration and impact stresses which require maximum strength and toughness. Such qualities result from employing the exact production techniques for the utmost IMPROVEMENT OF METALS BY FORGING. Throughout 31 years of technical production effort, our engineers have utilized, over and over again, all of the known forging techniques; frequently improving a technique in order to obtain maximum metal quality. Consult one of our forging engineers for suggestions on how to produce such parts to close tolerances.

*Reference Data Booklet presents many new ideas on forgings and their applications in many different kinds of equipment. Copies available to engineers, metallurgists and executives.*

DROP

THE STEEL IMPROVEMENT & FORGE CO.

FORGINGS 958 East 64th Street CLEVELAND, OHIO

# Service in a hurry

**Need alloys in a hurry? You'll get them in a hurry!**

**Two highly important factors make up the fast service every Falls customer knows:**

1. **Alloys on Hand. As America's largest producers of high quality alloys, we have more than 300 types constantly on hand, ready for shipment.**
2. **Delivery Timing. Falls Service is timed to today's requirements. No effort is spared to insure that badly needed alloys reach customers in the quickest time, by the shortest route.**

**And Falls knowhow and laboratory control make sure of the quality of every shipment.**

•

**For Alloy "Service in a Hurry" reach for your phone and call now!**

**Falls laboratory service and technical advice are always available to assist in the development of better castings. There is no obligation. Write today, or, better still, phone us. We welcome the opportunity to help in your alloy problems.**

*Our Telephone Number It's Buffalo Riverside 7812-3-4*

**NIAGARA FALLS SMELTING & REFINING CORPORATION**

*America's Largest Producers of Alloys*

**BUFFALO 17, NEW YORK**


## *WHAT'S NEW*

**IN MANUFACTURERS' LITERATU**

*Bibliography* of more than 7 papers dealing with the polar graphic method of metal analysis a a booklet discussing this equipme is offered by E. H. Sargent & C Bulletin 338.

*SR-4 strain gage* and illustratio of its many uses. Baldwin Sou wark. Bulletin 70.

*X-Ray Diffraction Unit.* Gener Electric X-ray Corp. Bulletin 72.

*New book* contains wealth of pra tical, usable information on ind trial inspection by x-ray. Westi house Electric & Mfg. Co. Bulletin

*Latest technical literature* on x- and radium protection, together w lead products catalog, has been sued by Bar-Ray Products, Inc. B letin 463.

*Industrial radiography* with dium. Canadian Radium & Urani Corp. Bulletin 79.

*Portable Brinell hardness tester* folding Brinell microscope. Andr King. Bulletin 85.

*Optical Aids.* Bausch & Lomb tical Co. Bulletin 94.

*Metallographic polishing* powd Conrad Wolff. Bulletin 96.

*New Norelco* electronic Searchl Modal 150 is described and seve features illustrated in this 4-p leaflet. North American Philips Inc. Bulletin 517.

*"Radiography of Materials"* is t of new 96-page book on indust radiography. Eastman Kodak Bulletin 331.

*High intensity* industrial illu nator is illustrated and described new leaflet by Kelley-Koett Mfg. Bulletin 406.

*30th Anniversary Catalog* sh the special metallurgical equipm offered by Claud S. Gordon Co. letin 410.

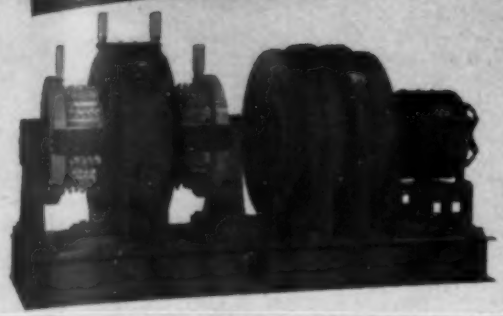

Use Handy Coupon on Page 1128 for Ordering Helpful Literature.

Other Manufacturers' Literature Li on pages 1120, 1122, 1124, 1126, 1128, 1134, 1136, 1138, 1140, 1142, 1144, 1147, 1148, 1150, 1152, 1154 and 115

COLUMBIA

# MOTOR GENERATORS

for Electroplating and other Electrolytic Processes



Columbia Generators embody every feature essential for dependable, 24-hour operation. They are built for electroplating service in sizes of 6 to 20 volts, 500 to 20,000 amperes, for anodic treatment of aluminum in sizes of 40, 50, and 60 volts, 500 to 3,000 amperes. Columbia Generators for other electrolytic processes range from ½ to 250 KW, 100 to 40,000 amperes, 6 to 60 volts.

Prompt shipment can be made on any type and size. Write for full information.

COLUMBIA ELECTRIC MFG. CO.
4519 Hamilton Ave., N. E. • Cleveland 14, Ohio

# CHAR CARBURIZERS

*Low*
DUSTING LOSS

The wear-resistant properties of the heavy carbon shell and the sealing of the energizing material within the particle combine to give CHAR CARBURIZING COMPOUND a very low dusting loss.

CHAR PRODUCTS COMPANY
MERCHANTS BANK BUILDING INDIANAPOLIS

*Outstanding*
## Solutions for Gas Analysis

**COSORBENT for determination of carbon monoxide**

1 Absorbs carbon monoxide cleanly to the last trace
2 Forms a stable compound with carbon monoxide
3 Has no vapor tension. — Absorbs oxygen slowly
4 Absorbs ethylene and acetylene and may be used for determining these gases
5 Will not absorb hydrogen, nitrogen, or methane and other saturated hydrocarbons

**OXSORBENT for determination of oxygen**

1 Removes all oxygen in two passes
2 Breaks sharply at the saturation point
3 Forms a stable compound with oxygen
4 Rises cleanly in the capillary
5 Absorbs four times its volume of oxygen

For more information on Burrell Gas Analysis Apparatus write for Bulletin 42-12.

# BURRELL
TECHNICAL SUPPLY COMPANY
1936-42 Fifth Avenue • Pittsburgh 19, Pa.

**ZIV'S NEW**
**Carbide Tipped**
**TOOLS**

This new carbide tip, a special product backed by Ziv's 33 years of experience, assures greater economy and higher production in your tooling operations. Available in standard shapes. Special shapes on request. Four grades of Ziv's carbide tips to select. Come ready for use.

**TOOL AND DIE STEELS**

You will find our stock of carbon alloy, high speed tool and die steels the finest. You can select exactly what you want for your particular tooling operation. Order what you need today.

**Branch Offices and Warehouses**

1316 South Rockland—Calumet, Mich. Calumet 1022
14643 Meyers Road—Detroit 27, Mich. Hogarth 0038
420 West South St.—Indianapolis 4, Ind. Franklin 4292
3731 W. Highland Blvd.—Milwaukee 8, Wis. West 1286
1617 North 7th St.—St. Louis 6, Mo. Central 4310

**District Representatives**

Columbus 16, Ohio—Smith Bros. Hardware Co.—580 North Fourth St.
Kansas City 10, Mo.—Richards & Conover Hardware Co.
Minneapolis 1, Minn.—Northern Machinery & Supply Co., Lumber Exchange Bldg.
New Orleans 9, La.—Woodward Wight & Co., Ltd.
Salt Lake City 9, Utah—Salt Lake Hardware Co.
Springfield 4, Mass.—Agawam Tool Co., 77 Napier St.

**FREE**

New 84 page, illustrated handbook of tool and die steels, useful, informative. Write today.

ESTABLISHED 1911
ZIV STEEL & WIRE CO.
2945-2951 W Harrison St. Chicago 12, Illinois


# *WHAT'S NEW*

**IN MANUFACTURERS' LITERATURE**

*Details and various applications* of the portable tensile tester are shown in 8-page leaflet by W. C. Dillon & Co., Inc. Bulletin 491.

*Advantages and speed* of testing with the Magnetic Analysis Corp.'s Comparator are described and pictured in brochure just released. Bulletin 492.

*8-page illustrated leaflet* describes line of industrial instruments offered by the Brush Development Co. Bulletin 428.

*Hardness testing equipment.* Wilson Mechanical Instrument Co., Inc. Bulletin 98.

*New Carbon and Sulphur* Determinator is described in this new 8-page leaflet. Harry W. Dietert Co. Bulletin 501.

*Many tips and suggestions* for industrial laboratories are presented in 24-page March issue of "Curves and References" by Wilkens-Anderson Co. Bulletin 502.

*4-page folder* on the inspection and control of surface finish is offered by George Scherr Co. Bulletin 508.

*6-page leaflet describes* the constant temperature equipment offered by American Instrument Co. Bulletin 493.

*New 50 KV industrial x-ray unit,* its features and applications, are presented in this 8-page leaflet. Picker X-Ray Corp. Bulletin 525.

*Metallurgical Equipment.* Adolph I. Buehler. Bulletin 97.

*Attractive, illustrated booklet* describes Clark Instrument's precision hardness tester. Bulletin 318.

## TEMPERATURE CONTROL

*The Rheotrol,* for maintaining desired power or heat input or flow of liquids or gases, and the new automatic and manual type Inputrols, are described in two new 4-page leaflets by Wheelco Instruments Co. Bulletin 611.


Use Handy Coupon on Page 1120 for Ordering Helpful Literature.
Other Manufacturers' Literature Listed on pages 1120, 1122, 1124, 1126, 1128, 1130, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1147, 1148, 1150, 1152, 1154 and 1156.



**IMMEDIATE DELIVERY**

•

ALLOY
and
CARBON GRADES
AS ROLLED, ANNEALED
and
HEAT TREATED
MACHINERY STEELS
COLD FINISHED
and
HOT ROLLED

•

TOOL STEELS
HIGH SPEED
and
CARBON GRADES
DRILL ROD — TOOL BITS

•

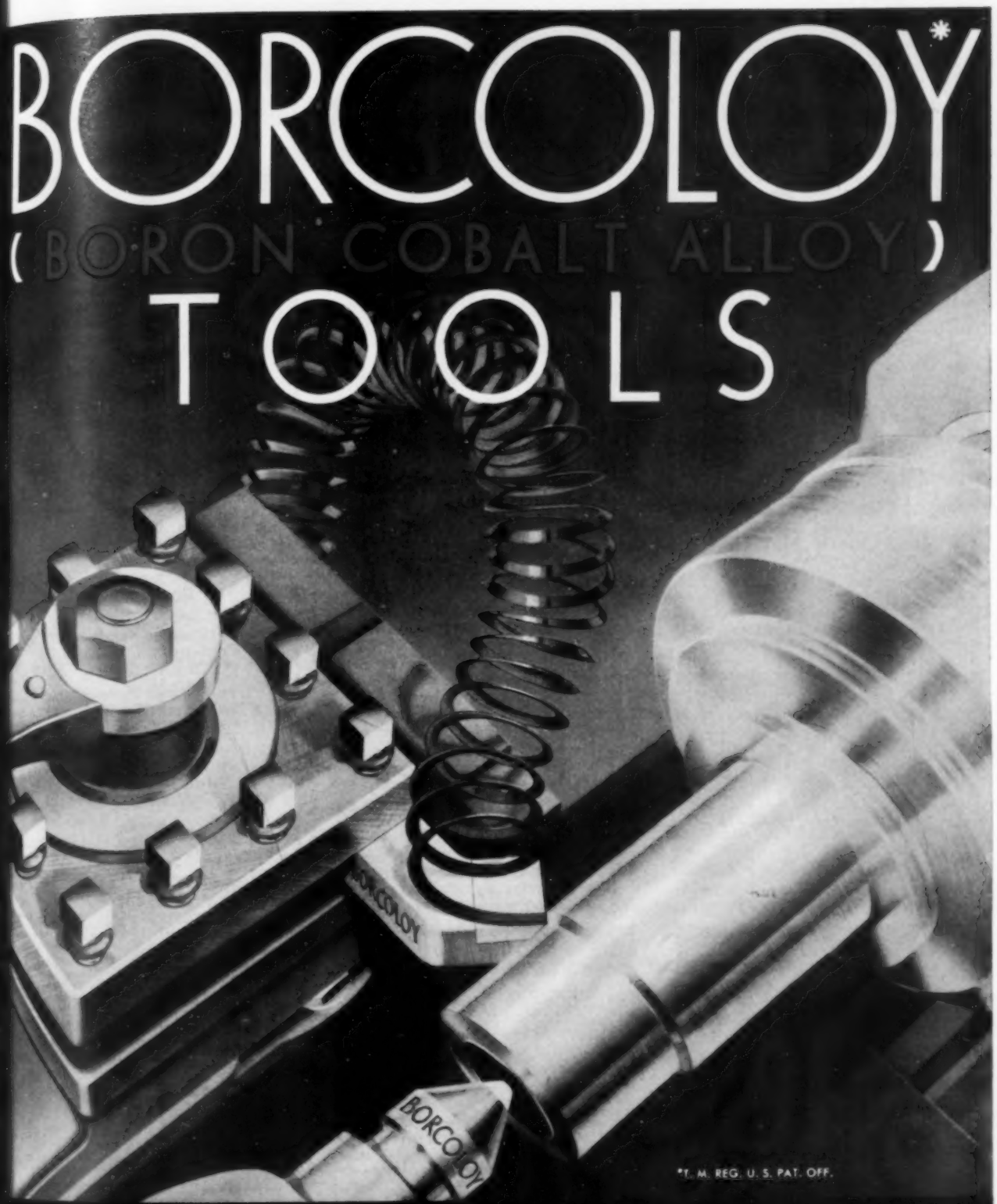
SPECIAL PLATES
FLAME CUTTING
FLAT GROUND STOCK
BROACH TYPE
HACK SAWS

•

**BENEDICT-MILLER INC.**

216 Clifford St., Newark 5, N. J.
N. J. Phone: MArket 3-6400
N. Y. Phone: REctor 2-2732

# BORCOLOY*
## (BORON COBALT ALLOY)
# TOOLS




*T. M. REG. U. S. PAT. OFF.

A NEW, SUPER HIGH-SPEED, TOOL STEEL WITH, (1) ALL THE DISTINCTIVE FEATURES OF "CENTRIFUGALLY CAST" ALLOYS, (2) HIGH WEAR RESISTANCE DUE TO THE PRESENCE OF BORON AND (3) A MAXIMUM RED HARDNESS IMPARTED BY TWENTY PERCENT COBALT

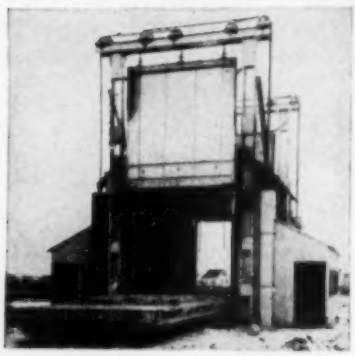
GENERAL AIRCRAFT EQUIPMENT, INC.
SOUTH NORWALK, CONN. TOOL DIVISION

*For Fast · Uniform · Precise Heat Treating of Steel Products*

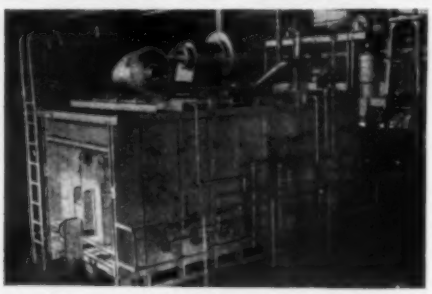
OIL · GAS · ELECTRIC
ANY APPLICATION
ANY CYCLE—ANY QUANTITY

ROCKWELL SINCE 1888 BUILT

**ROCKWELL**
**Batch or Continuous**
**FURNACES**



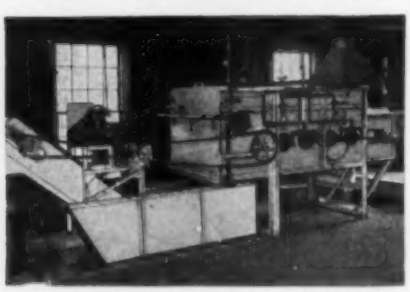
*Oil fired car bottom furnace for stress relieving large steel welded pressure vessels.*



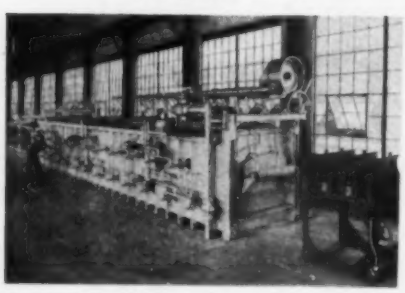
*Gas fired recirculating type strain relieving furnace for small castings.*

*Tray pusher type, oil fired furnace for annealing and normalizing forgings.*

*Oil fired, double chamber (preheat and heat) forging furnaces.*



*Continuous belt conveyor gas fired hardening furnace with automatic quench and unload.*



*Gas fired, continuous, catenary type, stainless steel strand annealing furnace.*

Whether in a small hearth furnace, a large car or a continuous conveyor furnace, when it's in a Rockwell your steel products get uniform, unvarying "heat treatment"—not just heating. There's a world of difference.

Let Rockwell furnace engineering help make your "heat treating" process more efficient—your product better.

**W. S. ROCKWELL COMPANY**
BATCH TYPE & CONVEYOR FURNACES FOR EVERY HEATING APPLICATION
46 CHURCH STREET NEW YORK 7, N. Y.


## *WHAT'S NEW*

**IN MANUFACTURERS' LITERATU**

*An 8-page leaflet* describing a n line of air-operated controll known as the Model 93 series, just been issued by the Bristol Detailed information is given ab the instruments for the control te perature, pressure, vacuum, liqu level, humidity and flow. Bulle 612.

*Ratio Control* and its applicati to many types of proportioning the process industries is descri in this 16-page booklet by Aska Regulator Co. Bulletin 616.

*A portable instrument* for meas ing temperatures of glowing obje is described in 16-page catalog "O tical Pyrometer" recently reprin with minor changes by the Leed Northrup Co. Bulletin 569.

*Potentiometer temperature* indi tors. Foxboro Co. Bulletin 82.

*Micro-Optical Pyrometers.* Pyro eter Instrument Co. Bulletin 89.

*Pyrometer control* of high spe salt baths is described in new bo let by Brown Instrument Co. Bu tin 324.

*Industrial thermocouples.* Ark S. Richards Co. Bulletin 93.

*Operating principle* and typ available of the synchronous-mot driven cam program timer are c ered in this new 4-page folde Automatic Temperature Control C Inc. Bulletin 487.

*Alnor Pyrocon,* the contact pyro eter for surface temperatures, described in this 6-page leaflet Illinois Testing Laboratories, I Bulletin 558.

**HEATING • HEAT TREA MENT**

*New bulletin MP115* describes F. Holden Co.'s flow heat treatm for bright hardening, bright temp ing and hot quenching. Bulletin 5


Use Handy Coupon on Page 1120 for Ordering Helpful Literature.
Other Manufacturers' Literature Lis on pages 1120, 1122, 1124, 1126, 1128, 1 1132, 1136, 1138, 1140, 1142, 1144, 1 1147, 1148, 1150, 1152, 1154 and 1156.

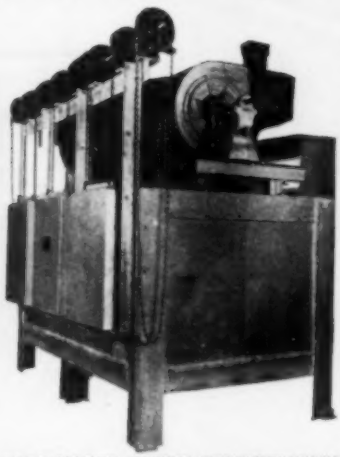
For *Your*

**WAR OR POST WAR RESULTS**

USE

**CARL-MAYER HI-SPEED ROD BAKER**

The fastest rod baker built! Saves up to 50% in time and fuel. Patented Blow-Off Feature removes moisture without bumping or agitating the coils. *Patented and patents pending.*



**CARL-MAYER BATCH TYPE FURNACE**

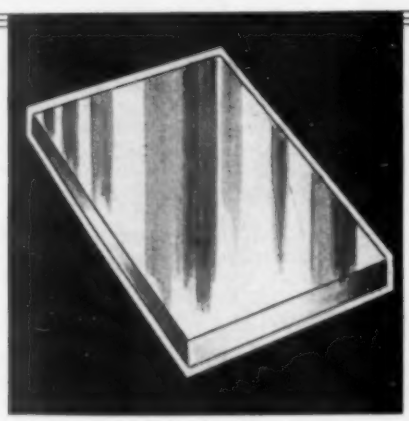
Carl-Mayer Recirculating Air Heater Type Batch Furnace, Gas Fired. Numerous batch type furnaces similar to this at Aluminum Co. of America, American Magnesium Corp., Thompson Products Co. and other leading plants.

Carl-Mayer has been serving industry over a quarter century. Ask for a Carl-Mayer Engineer or Bulletin No. 241.

**THE CARL-MAYER CORPORATION**

3030 EUCLID AVE., CLEVELAND, OHIO





# G. O. CARLSON, INC.

*Stainless Steels*

**PLATES, FORGINGS, BARS, SHEETS & BILLETS**

Stainless steels are our business — and we've built a backlog of engineering experience in this field that means quality service for you . . . We offer you a complete range of sizes that include the world's largest stainless plates. Let us work with you on your next job.

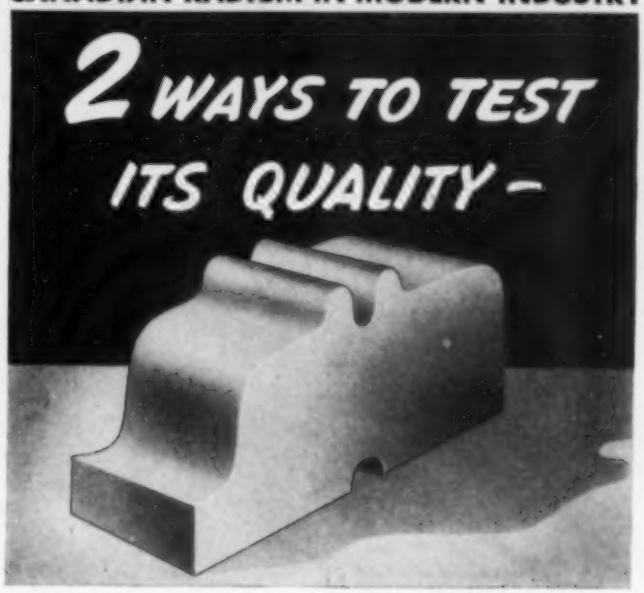
*Dependability • Engineering Experience • Quality Service*

**G. O. CARLSON, INC.**

THORNDALE, PA.



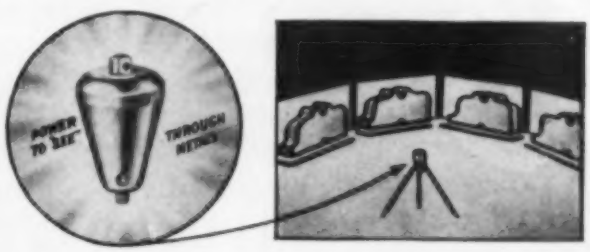
**CANADIAN RADIUM IN MODERN INDUSTRY**




## 1 – BREAK IT DOWN . . . OR 2 – RADIOGRAPH IT!

(CANADIAN RADIUM HAS BEEN KNOWN TO PAY FOR ITSELF ON A SINGLE JOB!)

The "break-down" method consumes time, labor and vitally needed material—a practice that appears primitive compared with modern radiography. A radium capsule (you can rent or buy) and a supply of films are all you need to locate and clearly identify all types of internal flaws in castings and welds. Radium is compact, portable—requires no power, no attachments, no repairs, no "servicing." Readily available in units suited to the needs of your plant.



R-144

*Write for Free Manual*

Reliable, profusely illustrated 80-page textbook on the fundamentals and technique of modern industrial Radiography of Metals with Radium. Specially prepared for the metals industry by our research and technical staff. Write for your copy today, giving your name and company position.

**CANADIAN RADIUM & URANIUM CORPORATION**

630 FIFTH AVE., ROCKEFELLER CENTER, NEW YORK 20, N.Y.

COLD FINISHED .45+ CARBON OPEN HEARTH

# SPEED TREAT STEEL

*Perfect results from*

## FLAME or INDUCTION HARDENING *plus* FAST MACHINING

**FLAME or INDUCTION HARDENING**

of SPEED TREAT STEEL results in hardness of 60 to 62Rc. with water quench and 56 to 58Rc. with oil quench.

**FAST MACHINING**

SPEED TREAT STEEL machines consistently at 170 S.F.P.M. with excellent tool life and fine finish. Plants report production increases of 35 to 55% — scrap loss reductions of 50 to 75% — doubled tool life and actual dollar savings running as high as $69 per ton of steel used.

BUY
WAR BONDS

*Our Metallurgists Are At Your Service.*
WRITE FOR SPEED TREAT CATALOG

Licensor
**MONARCH STEEL COMPANY**
HAMMOND · INDIANAPOLIS · CHICAGO
PECKOVER'S LTD., Toronto, Canadian Distributor

Licensee for Eastern States
**THE FITZSIMONS COMPANY**
YOUNGSTOWN, OHIO
MANUFACTURERS OF COLD FINISHED CARBON AND ALLOY STEEL BARS

# *WHAT'S NEW*

**IN MANUFACTURERS' LITERATURE**

*Lithium Metallic Vapor* atmosphere furnaces, principles and data, are presented in this illustrated 20-page booklet. Lithium Co. Bulletin 605.

*Spotting Surface Combustion* furnaces out of the heat room and into the production lines is described in this leaflet. Bulletin 607.

*Rotary carburizing furnaces*—gas, oil and electric—are illustrated and described in this 4-page leaflet by W. S. Rockwell Co. Bulletin 608.

*24-page Catalog* Section M-8802 describes Karbate corrosion resistant heat exchange equipment. Booklet sets forth several charts and tables covering heat conductivity and physical and chemical properties of carbon, graphite and Karbate materials. National Carbon Co., Inc. Bulletin 570.

*Electric Furnaces.* Ajax Electrothermic Corp. Bulletin 106.

*Radio frequency* generators for cutting heating time are described by Westinghouse Electric & Mfg. Co. in Bulletin B-3261-A and Descriptive Data 85-800. Bulletin 577.

*40-page booklet* contains complete information on cold treating, including new procedures, applications, performance data stories, etc. Deep-freeze Div., Motor Products Corp. Bulletin 578.

*Junior Quencher* for controlled quenching where small pieces are heat treated is described in 4-page leaflet by Bell & Gossett Co. Bulletin 591.

*New 12-page* fully-illustrated bulletin on heat treating ovens has just been published by Young Brothers Co. Illustrated are typical examples of ovens for heat treating aluminum and magnesium parts, for aging, stabilizing and hydrogen relief of plated parts, for pre-heating, for temper drawing and for stress relief. Bulletin 599.

*Chapmanizing* imparts costly alloy-hardness to steels faster than any other process, according to literature available from the Chapman Valve Mfg. Co. Bulletin 600.

**Use Handy Coupon on Page 1120 for Ordering Helpful Literature.**

**Other Manufacturers' Literature Listed on pages 1120, 1122, 1124, 1126, 1128, 1130, 1132, 1134, 1138, 1140, 1142, 1144, 1146, 1147, 1148, 1150, 1152, 1154 and 1156.**

# PENETRATION

## one of the chief reasons for the remarkable strength of joints brazed with EASY-FLO

The complete penetration you get with EASY-FLO, even in joints of large area, is well illustrated in this gun recoil part. It is made by brazing a hex and threaded collar to a tube. A ring of 1/16" EASY-FLO wire is preplaced at the tube end (top) and heating is done with a two-flame oxyacetylene torch. The brazing takes only 30 seconds.

If you were watching the job, you would see the alloy appear at the lower end of the joint a few seconds after EASY-FLO's low melting temperature of 1175°F. is reached.

This rapid penetration is due to EASY-FLO's exceptional fluidity—one of the important advantages derived from its silver-bearing composition as originated by Handy & Harman. It explains why properly made EASY-FLO brazed joints are always so strong and gas and liquid tight.

The sound, strong joints EASY-FLO makes, coupled with the labor-saving, production-boosting **speed** and surprising **economy** of low-temperature EASY-FLO brazing, account for widespread use of EASY-FLO throughout industry. Such results are vital to metal joining today, tomorrow and always. That's why, if you are not already using EASY-FLO, it will pay you to find out now, what it can do for you.

BULLETIN 12-A will give you the convincing EASY-FLO details. Write for your copy—today.

ARMY E NAVY

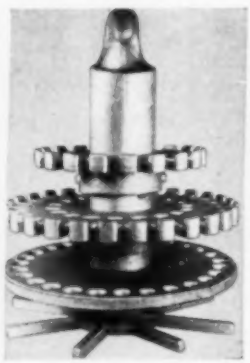
HANDY & HARMAN

82 FULTON ST., NEW YORK 7, N. Y.

Bridgeport, Conn. • Chicago, Ill. • Los Angeles, Cal. • Providence, R. I. • Toronto, Canada

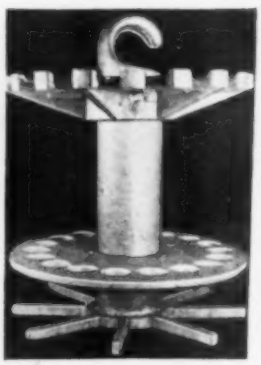
Agents in Principal Cities

# WHEN EXTREMELY ACCURATE SUPPORT IS REQUIRED SEE *Sterling*



These are carburizing fixtures used for holding light slender gears for airplane engines. Because of the temperature at which these parts are treated, they must be precisely supported. Irregularities or imperfections in the fixture would cause distortions which, though slight, would destroy the usefulness of the gears.

Specially designed by Sterling, these and scores of other precision fixtures are helping to speed war production. Let Sterling help with *your* problems.



G. C. McCORMICK, President
W. R. BLAIR, Vice President
H. I. DIXON, Sales Manager

**DISTRICT ENGINEERING OFFICES**

NEW YORK CITY
R. B. Steele
254 West 31st St.
Long. 5-5296

KEOKUK, IA.
J. Sonnenfeld
206 North 7th St.
Tel. 1434

PHILADELPHIA
Thomas J. Donovan, Jr.
1615 N. 2nd St.
Regent 4616

DAYTON, O.
A. F. Tenney
132 N. Main St.
Fulton 1866

BUFFALO
W. G. Merowit
436 Niagara St.
Madison 1233

CLEVELAND
Harry A. McDonough
E. F. Kraft
1740 East 12th St.
Main 0183

DETROIT
C. C. Miller, R.P.E.
8186 Livernois Ave.
Tyler 5-3338

CHICAGO
Harry N. Steffen, Jr.
4821 W. Cortland St.
Berkshire 7689

PITTSBURGH
John N. Berger, R.P.E.
1200 Standard Life Bldg.
Atlantic 5476

MILWAUKEE
E. W. Bock
4165 N. Newhall St.
Church 3890-R

SPRINGFIELD, MASS.
Associated Engineers
83 State St.
Tel. 3-4321

STERLING ALLOYS, Inc.
WOBURN, MASS.


## *WHAT'S NEW*

IN MANUFACTURERS' LITERATURE

*Attractive 4-page leaflet* describ uses, construction features and de sign of electric car bottom furnace Hevi Duty Electric Co. Bulletin 53

*McKee "Walltite Proportioning* and "Entrainment" gas burners a described in new bulletin by Eclip Fuel Engineering Co. Bulletin 53

*Convection tempering* furnace with temperatures up to 1300 deg. are described in this new Hevi Du Electric Co. Bulletin 542.

*Internally heated salt bath furnace* and pots. Upon Electric Furnac Div. Bulletin 102.

*32-page booklet* describes 16 inte esting industrial uses of high fr quency electrical induction. Ohi Crankshaft Co. Bulletin 459.

*8-page* pictorial bulletin describ the heat treating service of Cont nental Industrial Engineers, Inc. B letin 107.

*"Isothermal Quench Baths* Applie to Commercial Practice" is the ti of this 12-page paper, a practic and useful discussion of S curves heat treatment. Ajax Electric C Inc. Bulletin 461.

*Quenching oil coolers* in heat tre ing practices are described in th leaflet by the Sims Co. Bulletin 4

*Induction heating.* Induction He ing Corp. Bulletin 103.

*Furnaces for heat treatment* of al minum, magnesium and their alloy Lindberg Engineering Co. Bulle 271.

*Gas, oil, and electric heat treati* and carburizing furnaces. Holcr & Co. Bulletin 114.

*Certain Curtain Furnaces.* C. Hayes, Inc. Bulletin 134.

*Industrial furnaces,* equipment f bright annealing stainless steels a ammonia dissociation equipme Drever Co. Bulletin 115.

*Industrial ovens,* rod bakers, wel ing rod ovens, furnaces. Carl-May Corp. Bulletin 116.

*Full muffle and other* heat treati furnaces described in catalog Charles A. Hones, Inc. Bulletin 11

*Non-metallic Electric* Heating E ments. Globar Div., Carborundu Co. Bulletin 119.


Use Handy Coupon on Page 1120 for Ordering Helpful Literature.

Other Manufacturers' Literature Lite on pages 1120, 1122, 1124, 1126, 1128, 11 1132, 1134, 1136, 1140, 1142, 1144, 11 1147, 1148, 1150, 1152, 1154 and 1156.

"BUZZER" HIGH SPEED *Gas* FURNACES

## *Attain High Temperatures*

**without BLOWER or POWER**
**... just connect to gas supply**

**FULL MUFFLE FURNACES** ... reach temperatures of 2400° F. without blower or power. Ideal for heat treating high speed and Alloy Steels. Also available in Bench Models.

**ATMOSPHERIC POT HARDENING FURNACES** ...tangentially-fired to assure even heat up to 1650° F. are used for Salt, Cyanide and Lead Hardening. Also adapted for Melting Aluminum.

***Send for the complete "BUZZER" Catalog***

**CHARLES A. HONES, INC.**
123 So. Grand Ave. Baldwin, L. I., N. Y.

## Spring Testing?

**USE THE PRECISION**

# DILLON TESTER

**For Compression or Tensile Testing**

Amazingly simple! Tests plastics, wire, steel, or SPRINGS up to 11" in length. Rapid changeover from tensile to compression or transverse testing.

Hand operated but may be motorized if desired. Checks specimens with tensile as high as 200,000 PSI. May be used with extensometer. Ball bearings throughout, and equipped with maximum hand.

Calibrated with Morehouse Proving Ring certified by U. S. Bureau of Standards. Handles long or short specimens, standard or special shapes. *Light* weight, *low* in cost, *beautifully* finished. 10 Day delivery. Hundreds in daily use by leading plants.

Stands only 37" and weighs approx. 132 lbs. Capacities from 0-250 lbs. up to 0-10,000 lbs. Setup above shows compression cage in place testing railroad spring. Write today for interesting 8 page folder in color.

**W. C. DILLON & CO., Inc.** 5420 WEST HARRISON ST. CHICAGO 44, ILL., U.S.A.

● *'Tis an ill wind that blows no good* is an old expression that particularly applies. McKee Centrifugal Pressure Blowers and Boosters are *tornados under control* — used for a steady reliable source of combustion air for gas and oil burners, for boosting weak gas main pressures, or in fact any application where air or gas must be delivered at pressures from 2 ounces to 2 pounds. With *centrifugal* machines, the pressure is constant regardless of the amount of consumption although the electric current consumed is in proportion to the actual amount of capacity used.

## *Write*

**for Bulletins K-100 and K-110**

**Eclipse Fuel Engineering Company**

ROCKFORD McKee Eclipse ILLINOIS

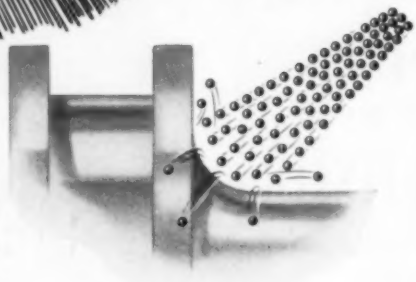
FATIGUE LIFE OF METALS

*Multiplied*

3 TO 15 TIMES

BY

Surface Peening



• In several fields, notably automotive and aeronautical, surface-peening (shot-blasting) is being extensively employed. Its use is spreading rapidly.

Surface-peening is accomplishing miraculous results in increasing fatigue life several hundred percent. By no other known method can such results be obtained—at so little cost.

Small parts are mass peened; large parts individually.

Surface-peening may offer undiscovered possibilities in improving your products.

We shall be glad to discuss methods and equipment with you.

*ASK FOR SURFACE-PEENING BULLETIN*

**THE W. W. SLY MANUFACTURING CO.**

**4767 TRAIN AVENUE**

**CLEVELAND 2, OHIO**

SLY SURFACE-PEENING


## *WHAT'S NEW*

**IN MANUFACTURERS' LITERATURE**

*56-page vest pocket data book* on heat treating practices and procedures. Chicago Flexible Shaft Co. Bulletin 118.

*Molten Salt Baths.* E. I. duPont deNemours & Co., Inc., Electrochemicals Department. Bulletin 123.

*Handling* cylinder anhydrous ammonia for metal treaters. Armour Ammonia Works. Bulletin 128.

*Air-Oil Ratiotrol for proportioning* flow of fuel oil and air to oil burners. North American Mfg. Co. Bulletin 135.

*Two new bulletins* on vertical carburizers and on carbonia finish. American Gas Furnace Co. Bulletin 139.

*Controlled atmosphere furnaces.* Delaware Tool Steel Corp. Bulletin 141.

*Dual-Action quenching oil.* Gulf Oil Co. Bulletin 132.

*Heat treating,* brazing and melting of ferrous and non-ferrous metals. Lepel High Frequency Laboratories, Inc. Bulletin 147.

*Industrial Carburetors.* C. M. Kemp Mfg. Co. Bulletin 143.

*Vertical Furnace.* Sentry Co. Bulletin 148.

*Furnaces.* Tate-Jones Co. Bulletin 142.

*Conveyor Furnaces.* Electric Furnace Co. Bulletin 149.

*High and low temperature* direct fired furnaces. R. S. Products Corp. Bulletin 146.

*New Electric Furnace.* American Electric Furnace Co. Bulletin 150.

*Electric Furnaces* for laboratory and production heat treatment. Hoskins Mfg. Co. Bulletin 152.

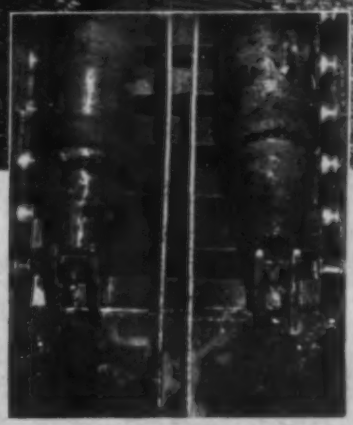
*"The Lectrodryer* in the metallurgical industries," a new 4-page bulletin by Pittsburgh Lectrodryer Corp. Bulletin 155.

*High Temperature Fans.* Michiana Products Corp. Bulletin 158.

*Pictorial bulletin* describes furnaces for heat treating, normalizing, annealing, forging. Vulcan Corp. Bulletin 161.


Use Handy Coupon on Page 1120 for Ordering Helpful Literature.

Other Manufacturers' Literature Listed on pages 1120, 1122, 1124, 1126, 1128, 1130, 1132, 1134, 1136, 1138, 1142, 1144, 1146, 1147, 1148, 1150, 1152, 1154 and 1156.



## "With Gulf Super-Quench we get

# more uniform hardness and improved machinability"

*says this shell plant heat treating Superintendent*

VARIATIONS IN HARDNESS with conventional quenching oils resulted in unsatisfactory tool life in the machine shop," says the heat treating Superintendent of American Manufacturing Company, Fort Worth, Texas. "With Gulf Super-Quench we get uniform hardness in every shell, which has led to a substantial increase in tool life."

Another heat treating problem solved with Gulf Super-Quench! And additional evidence that it pays to equip your plant with this revolutionary new quenching oil.

Here's why Gulf Super-Quench is a superior quenching oil: It has intensified dual-action—a faster cooling rate through the hardening temperature range, and the slow speed of conventional quenching oil below the hardening temperature range. Call in a Gulf Service Engineer today and let him show you how Gulf Super-Quench can help improve your quenching practice. For your copy of the brochure on Gulf Super-Quench, send the coupon below.

*BACK THE INVASION . . .*
*BUY MORE WAR BONDS!*

Gulf Oil Corporation · Gulf Refining Company MP
3800 Gulf Building, Pittsburgh 30, Pa.

Please send me, without obligation, a copy of the brochure, "Gulf Super-Quench."

Name.....

Title.....

Company.....

Address.....

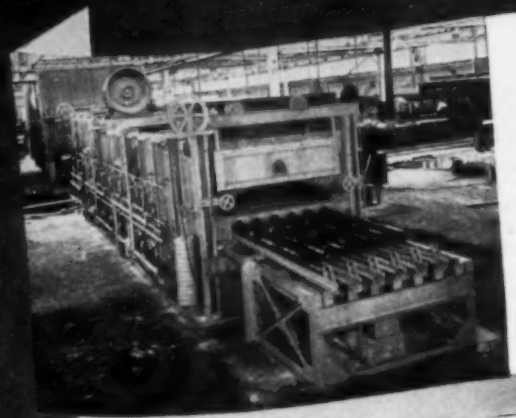
GULF INDUSTRIAL LUBRICATION

**GULF OIL CORPORATION · GULF REFINING COMPANY**
Gulf Building, Pittsburgh 30, Pa.

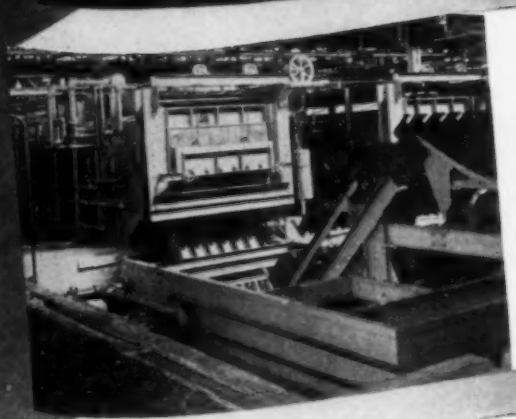
It Takes the Best to Make the Best

*Prepare*

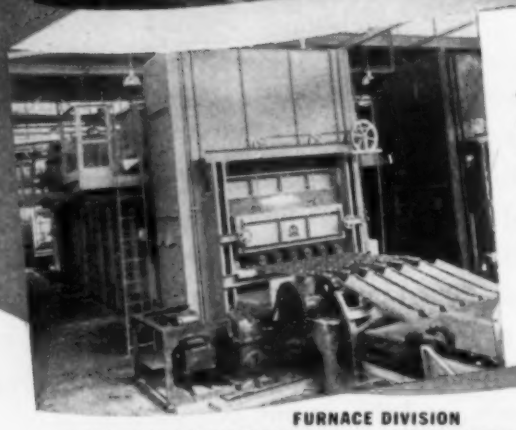
for Post-War Production with R-S Continuous Furnaces



Unexcelled engineering ability in the production of heat-treated heavy artillery shells is exemplified by this automatic, gas-fired R-S installation. The shells are pushed through the hardening furnaces in six parallel conveying tubes.



Shells are quenched internally and externally, then leave the quench tanks on continuous conveyors.



The draw furnaces, through which the shells move on alloy chains. The result is uniform heat-treatment and low cost production.

FURNACE DIVISION

R-S PRODUCTS CORPORATION

128 Berkley Street • Philadelphia 44, Pa.

R-S Furnaces of Distinction

PLATE AND ANGLE HEATING

ANNEALING · CONVECTION · CAR HEARTH · ROTARY HEARTH

CONTINUOUS CONVEYOR · SALT BATH · FORGING · METAL MELTING

*Buy War Bonds*

# *WHAT'S NEW*

## IN MANUFACTURERS' LITERATURE

*Flame-type* mouth and taper annealing machine for steel cartridge cases. Morrison Engineering Corp. Bulletin 154.

*Turbo-Compressor data* booklet shows how to calculate compressed air systems for a dozen different applications. Spencer Turbine Co. Bulletin 329.

*No-Carb*, a liquid paint for prevention of carburization or decarburization. Park Chemical Co. Bulletin 156.

*Catalog* of heat treating materials. Heatbath Corp. Bulletin 322.

*Standardized sizes* of semi-muffle and pot-type furnaces are described and pictured in new leaflet by Dempsey Industrial Furnace Corp. Bulletin 354.

*Use of pulverized coal* in the metallurgical industries, equipment and designs, are described by Amsler-Morton Co. in Bulletin 361.

*Line of Altitude Chambers* in which products and materials may be tested at any given altitude, temperature and degree of humidity is described in new catalog issued by Kold-Hold Mfg. Co. Bulletin 549.

*"Why Heat Treat in Baths?"* is the title of an interesting discussion by the Bellis Heat Treating Co. on the use of liquid heating media and the latest Edicurrent Furnaces. Bulletin 560.

*Laboratory and tool room furnaces* Mahr Mfg. Co. in new Bulletin 327.

*82-page catalog* describes in detail General Electric heat treat furnaces. Bulletin 380.

*Furnaces for heat treating tools* dies and parts are described in new leaflet by Despatch Oven Co. Bulletin 362.

*New booklet* describes uniform case hardening up to .150" with controlled carburizing baths. American Cyanamid & Chemical Corp. Bulletin 372.

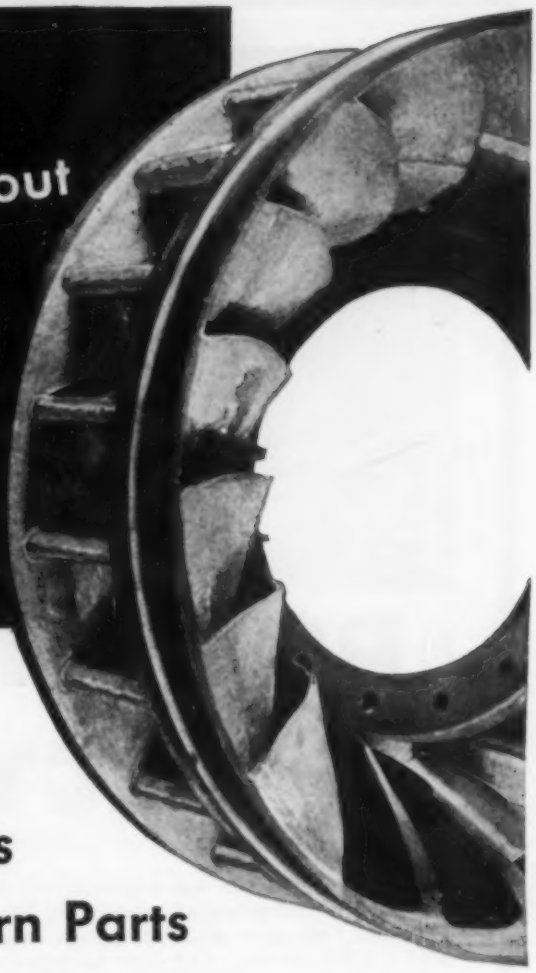
*New book "Hardness"* describes and evaluates hardness research of noted pioneers, methods of testing and testing instruments. Nitralloy Corp. Bulletin 366.

*Four basic heat treating* atmospheres are described in new booklet by Westinghouse. Bulletin 383.

Use Handy Coupon on Page 1120 for Ordering Helpful Literature.

Other Manufacturers' Literature Listed on pages 1120, 1122, 1124, 1126, 1128, 1130, 1132, 1134, 1136, 1138, 1140, 1144, 1146, 1147, 1148, 1150, 1152, 1154 and 1156.

Use it up · Wear it out
Make it do · Or do without
*Uncle Sam*



# *No need to "do without"—* Bronze Welding is Industry's No. 1 Tool for Salvaging Worn Parts

For building-up worn surfaces or making repairs to cast iron, malleable iron, steel or copper alloy parts, there's nothing so economical and dependable as Bronze Welding. That large bearing, for instance: It was worn out giving years of service on a nail making machine. Replacement from stock was impossible, yet the manufacturer just couldn't "do without." Built up with strong, tough, dense-grained Anaconda Manganese Bronze Welding Rod and machined, the bearing was quickly returned to service.

Or that 5,000 hp. turbine runner: Stones and gravel brought in with ice in the Spring badly damaged some of the buckets while others were broken off completely. Again Bronze Welding was used to build up the worn surfaces and weld in new patches. The cost, compared with that of a new runner, was negligible.

Maintenance men everywhere are taking advantage of the salvage and repair opportunities made possible with the oxy-acetylene torch and such rods as "997" Low Fuming, Tobin Bronze* and other Anaconda Welding Rods. Applications of these rods are described in Anaconda Publication B-13. Write for a copy.

*Reg. U. S. Pat. Off.

***Here's a Suggestion List***

Parts and place where Bronze Surfacing will "make it do"

Sheaves
Pulleys
Clutches
Thrust Plates
Bushings
Bearings
Hubs
Flanges
Pistons
Impellers
Pump Parts
Pipe Threads
Stripped Holes
Gear Teeth
Reciprocating Parts
*"Safe-ending"* Hammer Struck Tools

**THE AMERICAN BRASS COMPANY**

General Offices: Waterbury 88, Connecticut • Subsidiary of Anaconda Copper Mining Company

*In Canada:* ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

ANACONDA

*Anaconda Bronze Welding Rods*

# POST-WAR FACTS

**PEACE products, like war products, will require a lot of blast cleaning. Because of priorities, equipment for this blast cleaning can be delivered *only after VG day.* Based on actual experience, here are four FACTS showing why some concerns are assured of the shortest possible reconversion delay.**

**FACT 1** Today, a priority is issued only for the actual needs of war preparation.

**FACT 2** After VG day, the manufacturers *first* in operation will get headstarts on competition.

**FACT 3** Manufacturers who wait until VG day to place orders for blast cleaning—or *any* other equipment—will have to wait their turn for deliveries. With heavy demand a surety—this waiting could easily hamstring the most carefully prepared post war program.

**FACT 4** *Therefore*—PLACE YOUR ORDERS NOW. Equipment will not be delivered of course, but as soon as your orders are "on the books" *you benefit* by being in line for earliest deliveries. You avoid delay—and possible serious financial loss—by PLACING YOUR ORDERS NOW.

A *headstart* is better than a *headache.* We have already received orders from concerns for delivery after VG day. Why don't you make your post war plans fool proof by getting in *the delivery line now.* For data—or literature—or a visit from one of our district engineers—

"COME TO PANGBORN"

# PANGBORN

WORLD'S LARGEST MANUFACTURER OF DUST COLLECTING AND BLAST CLEANING EQUIPMENT

PANGBORN CORPORATION · HAGERSTOWN, MD.


## *WHAT'S NEW*

**IN MANUFACTURERS' LITERATU**

*The complete line* of heat treati furnaces, burners and other equi ment of this company is describ and illustrated in new bulletin " just issued. Eclipse Fuel Engine ing Co. Bulletin 483.

*Vapocarb-Hump method* for he treatment of steel is the title of newly-revised catalog issued Leeds & Northrup. Bulletin 453.

*"Heat Treating Topics"* is title new bulletin of special interest heat treaters, issued by Rex & Er Bulletin 424.

*A new technical bulletin* giv information on Calliflex Bi-met Callite Tungsten Corp. Bulletin 47

*112 pages packed solid* with dow to-earth data on industrial combu tion and heat practice. Hauck M Co. Bulletin 477.

*Aero Heat Exchangers* for the co stant and accurate control of tempe ature in liquids or gases are d scribed in this 4-page leaflet Niagara Blower Co. Bulletin 516.

*Gas-fired tool room furnaces* a pot furnaces are described in the two booklets by Bellevue Industri Furnace Co. Bulletin 522.

*Merits and economy* of pulveriz coal firing for metallurgical furnace are discussed in this bulletin by Ba cock & Wilcox Co. Bulletin 530.

### REFRACTORIES & INSULATION

*4-page leaflet* describes Heart Patch, a fast-setting, fine-grain magnesia refractory for quick repa of deep bottom holes in basic ope hearth furnaces. Basic Refractori Inc. Bulletin 590.

*Conductivity* and heat transf charts. Johns-Manville. Bulletin 16

*Insulating firebrick.* Babcock Wilcox Co. Bulletin 162.

*Electric-furnace* graphite mol and sintering boats and carbon he treating boxes are described in Cat log Section M-8000. National Carbo Co. Bulletin 545.

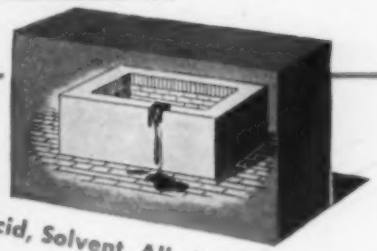
*"Carbofrax"* refractory skid ra are described and blueprinted f many types of furnaces in th 20-page booklet by the Carborundu Co. Bulletin 500.


Use Handy Coupon on Page 1120 for Ordering Helpful Literature.

Other Manufacturers' Literature Listed on pages 1120, 1122, 1124, 1126, 1128, 113 1132, 1134, 1136, 1138, 1140, 1142, 114 1147, 1148, 1150, 1152, 1154 and 1156.

# *Having Floor Trouble?*

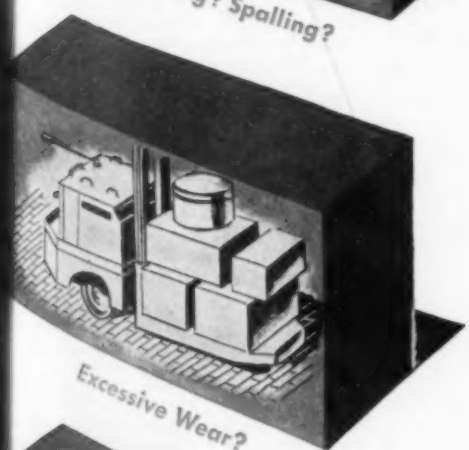
## LOOK WHAT "NATIONAL" CARBON BRICK FLOORING CAN DO FOR YOU!



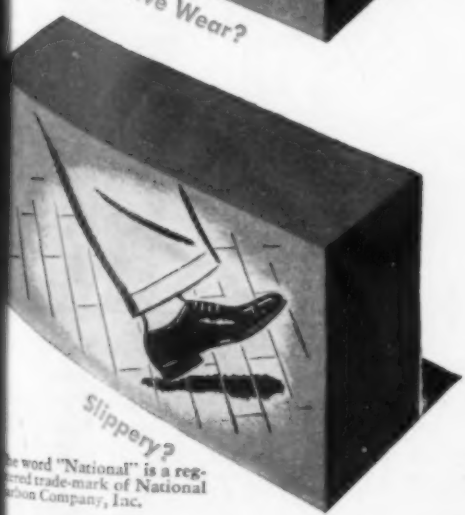
Acid, Solvent, Alkali Damage?

Static Dangers?

Sticking? Spalling?



Excessive Wear?



Slippery?

The word "National" is a registered trade-mark of National Carbon Company, Inc.

FOUNDRIES, glass works, chemical and processing plants, steel mills! These are a few of the places where industrial flooring may fail from reaction to acids, solvents, alkalies, and other severe conditions.

"National" carbon brick floors, set with "National" carbonaceous cements, are solving such difficult floor problems for more and more manufacturers. For "National" carbon brick is resistant to practically all acids (notably hydrofluoric), alkalies and other corrosive chemicals. It is not wet by molten metals or glass, preventing sticking. And its negligible coefficient of expansion eliminates spalling and cracking under extreme thermal shock.

Carbon's no-static property helps to add protection from fire and explosion. It is light in weight. It has a non-slippery surface. Its strength assures long life under heavy duty.

No other practical floor material provides all these advantages.

> The Chief Engineer* of a nationally known glass manufacturing company states: *"The ["National"] carbon brick flooring in use in our plant is giving excellent service under severe conditions where no other type of flooring previously used proved satisfactory."*
> *Name on request.

*Keep your eye on the infantry . . . the Doughboy does it!*

**NATIONAL CARBON COMPANY, INC.**

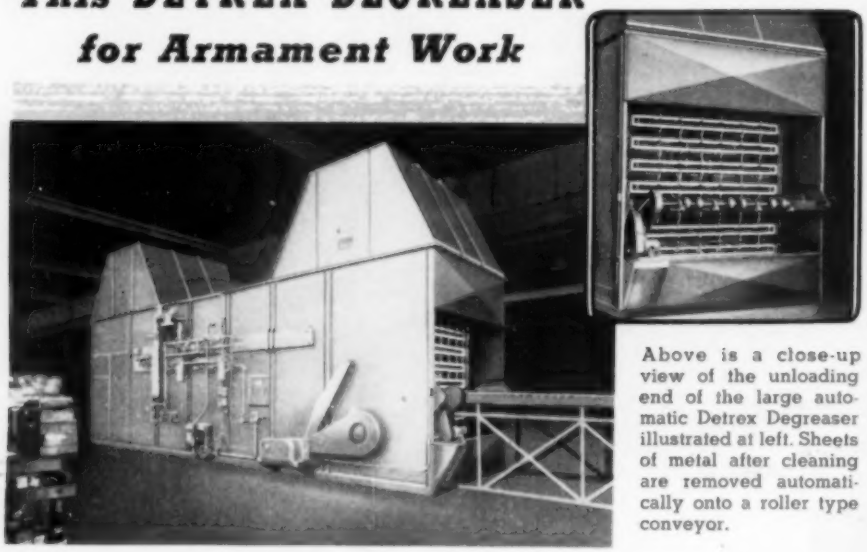
*Unit of Union Carbide and Carbon Corporation*

UCC

*General Offices:* 30 East 42nd Street, New York 17, N. Y.

*Division Sales Offices:* Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

## *This* DETREX DEGREASER *for Armament Work*



Above is a close-up view of the unloading end of the large automatic Detrex Degreaser illustrated at left. Sheets of metal after cleaning are removed automatically onto a roller type conveyor.

## IS DESIGNED TO HANDLE PEACETIME WORK

### *Without One Construction Change!*

In past months, Detrex engineers have designed many machines intended primarily for the cleaning of metal products required for armament purposes. But, in innumerable instances, their engineering work has gone further than the immediate purpose of the equipment. To help the customer reconvert to peacetime production quickly and at a minimum cost, equal consideration has been given to the type of products which will be produced after the war.

The Detrex Vapor-Spray-Vapor Degreaser shown above is now cleaning sheet steel. Without a single change, it will be used later for cleaning drum heads as well as sheets. In the case of other machines, minor changes will make possible almost immediate use of Detrex equipment in reconversion programs.

If your metal cleaning problems are those of today OR TOMORROW, call in a Detrex engineer. He can offer the advice and cooperation you're looking for.

KEEP BUYING U. S. WAR BONDS

**DETREX CORPORATION**

13006 HILLVIEW AVE., DETROIT 27, MICHIGAN


# *WHAT'S NEW*

## IN MANUFACTURERS' LITERATURE

*Wesgo super refractory shapes* are described in this bulletin. With ability to withstand almost any amount of thermal abuse, these shapes possess high fusing range (up to 3100 deg. F.), low thermal conductivity and complete freedom from impurities such as iron. Western Gold and Platinum Works. Bulletin 526.

*Zircon refractories* in aluminum open hearth furnaces. Chas. Taylor Sons Co. Bulletin 347.

*Steel Plant Cement* for hot or cold patching of soaking pits, open hearths, electric furnaces, forging furnaces and reheating furnaces is described in new folder by Electro Refractories & Alloys Corp. Bulletin 407.

*Heavy Duty Refractories.* Norton Co. Bulletin 164.

*D-E insulating materials* and their application are described in new data booklet by Armstrong Cork Co. Bulletin 208.

### FINISHING • PLATING • CLEANING

*Revised editions* of two bulletins — No. 8, Anodizing and No. 9, Cadmium Plating — have been issued by Kelite Products, Inc. Each one outlines the practice and technique of the operations involved. Bulletin 589.

*A protective, deep black finish* for steel. Heatbath Corp. Bulletin 17

*Cyanide zinc and bright zinc* plating with Turco Type X, Turco Porokleen and Turco Penetrol is described in this 10-page booklet by Turco Products, Inc. Bulletin 495.

*Helpful chart* classifies Cowles metal cleaners for improved cleaning operations. Cowles Detergent Co. Bulletin 594.

*Roto-Finish equipment* for deburring, buffing, polishing and coloring. Sturgis Products Co. Bulletin 170.

*"Deoxidine"* for a better rust removing and metal cleaning job is described along with several applications in this 4-page leaflet. American Chemical Paint Co. Bulletin 52

*Motor-Generators* for electroplating and other electrolytic processes. Columbia Electric Mfg. Co. Bulletin 173.


Use Handy Coupon on Page 1120 for Ordering Helpful Literature.

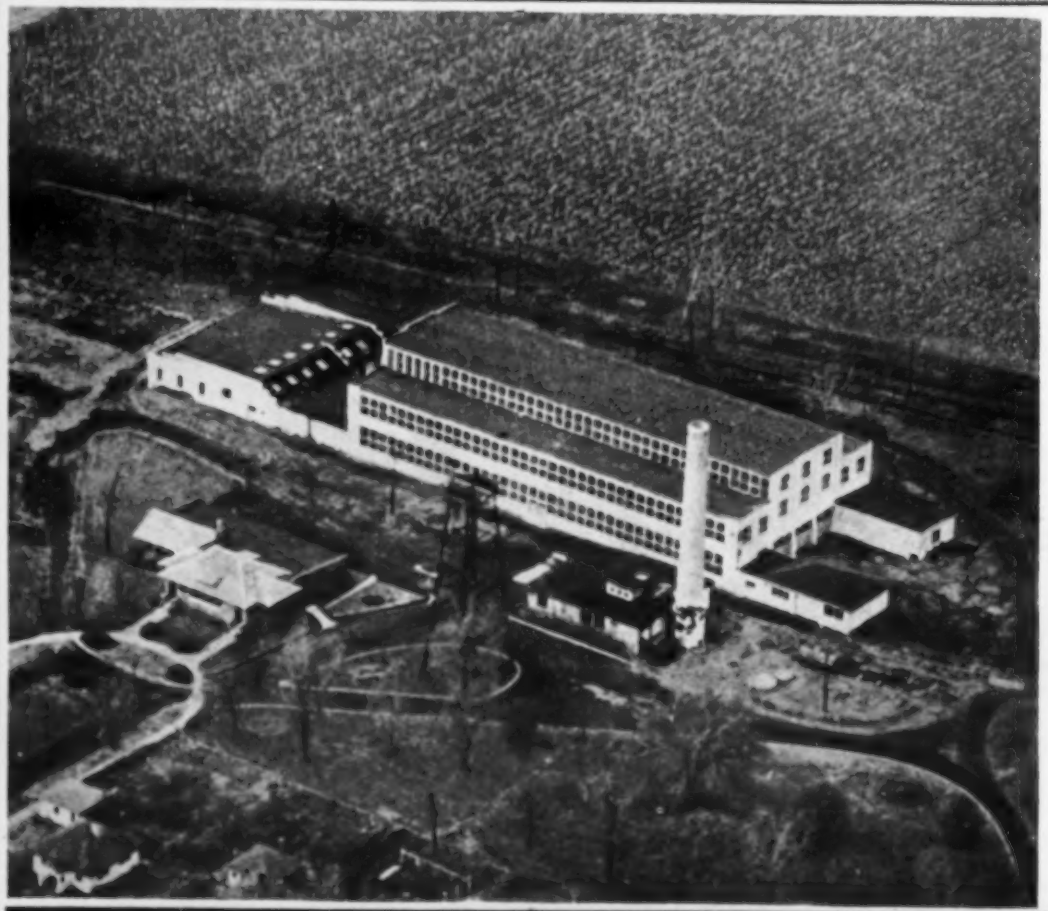
Other Manufacturers' Literature Listed on pages 1120, 1122, 1124, 1126, 1128, 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1147, 1148, 1150, 1152, 1154 and 1156.



If You Use Heat Resistant

# If You Use Heat Resistant Alloys in Your Heat Treat

*Mail The Coupon Now*



No better Alloy Plant than this 11 acre plant layout exists anywhere.

If You Visited The National Metal Congress At Chicago You Observed The Superiority Of ACC And Engineering ACCOLOY Castings By Direct Comparison. If You Use Heat Resistant Alloy Casting Or Furnace Parts, You'll Be Interested In This Unusual Booklet Of Which So Many People Have Requested Extra Copies.

ACC

## ALLOY CASTING COMPANY

CHAMPAIGN, ILLINOIS

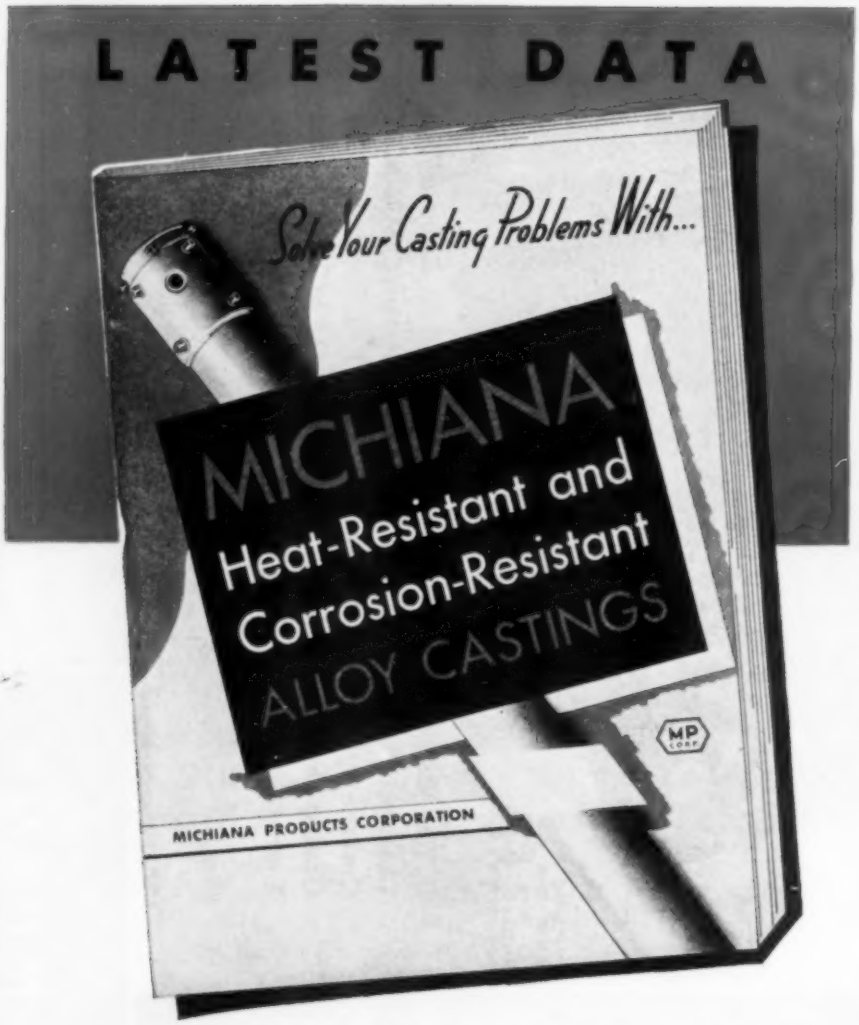
Alloy Casting Co., Champaign, Ill.
You may send me a copy of your new Booklet:

Name .....

Title .....

Company .....

Address .....




## ON MICHIANA HEAT- AND CORROSION-RESISTANT ALLOYS

War-time demands have demonstrated still further the ability to maintain uniform high standards in the production of MICHIANA Alloy Castings. Improved facilities and foundry technique,—added experience in meeting the requirements of a host of America's most important industrial organizations assure your getting castings that fit your exact requirements.

Our new literature contains the data on the various leading alloys with illustrations to indicate the wide range of usage. A copy of this new Booklet No. 110 will be mailed on request. MICHIANA PRODUCTS CORPORATION, Michigan City, Ind.

ARMY IE NAVY

MICHIANA
Heat-Resistant and
Corrosion-Resistant
ALLOY CASTINGS

- Muffles
- Boxes
- Rails
- Rolls
- Sprockets
- Retorts
- Pots
- Grids
- Tubes
- Chains
- Heat Exchangers


# *WHAT'S NEW*

**IN MANUFACTURERS' LITERATURE**

***Three new booklets*** have been issued by the Enthone Co. describing an acid addition agent, hard drying rust-inhibiting waxes and a new alkali steel cleaner. Bulletin 420.

***Alvey Ferguson Co.*** shows how various product washing problems were solved. Bulletin 172.

***Electrochemical Descaling.*** Bullard-Dunn Process Div., Bullard Co. Bulletin 212.

***Airless Rotoblast.*** Pangborn Corp. Bulletin 176.

***Rust inhibiting*** wax coatings for protection of metal. S. C. Johnson & Son, Inc. Bulletin 180.

***Tumbling and cleaning.*** Globe Stamping and Machine Co. Bulletin 179.

***Cadmium Plating.*** E. I. duPont deNemours & Co., Inc. Bulletin 17[illegible]

***Several practical*** data sheets show cleaning methods used on aluminum, brass and steel. Diversey Corp. Bulletin 446.

***"Surface-Peening"*** by shot-blasting to improve the strength of metal parts is described in this leaflet by W. W. Sly Mfg. Co. Bulletin 521.

***Lead plating is discussed*** in new booklet issued by Harshaw Chemical Co. Bulletin 109.

***Service report describes use*** of Oakite machining, drawing, degreasing and descaling materials. Oakite Products, Inc. Bulletin 210.

***Catalog*** on finishing and cleaning. Frederick Gumm Chemical Co., Inc. Bulletin 292.

***Jetal process*** and its characteristics as a protective coating. Alross Chemical Co. Bulletin 213.


**Use Handy Coupon on Page 1120 for Ordering Helpful Literature.**

**Other Manufacturers' Literature Listed on pages 1120, 1122, 1124, 1126, 1128, 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1147, 1150, 1152, 1154 and 1156.**

## SPOT YOUR BUYING POINT!

**NEW ENGLAND**
BOSTON, MASS.
H. Boker & Co., Inc.

**MIDDLE ATLANTIC**
BUFFALO, N. Y.
Root, Neal & Co.
ERIE, PA.
Boyd Welding Co.
NEW YORK CITY
H. Boker & Co., Inc.
PHILADELPHIA, PA.
Arcos Corporation
PITTSBURGH, PA.
Williams & Co., Inc.
ROCHESTER, N. Y.
Welding Supply Co.
SYRACUSE, N. Y.
Welding Supply Co.

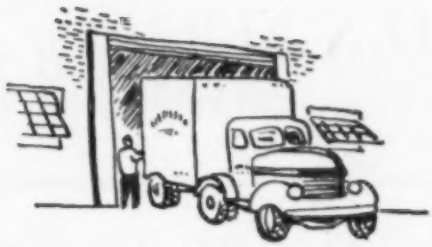
**SOUTH and SOUTHWEST**
BATON ROUGE, LA.
Wm. D. Seymour Co.
BORGER, TEXAS
Hart Industrial Supply Co.
HOUSTON, TEXAS
Champion Rivet Co. of Texas
KINGSPORT, TENN.
Slip-Not Belting Corp.
PAMPA, TEXAS
Hart Industrial Supply Co.
OKLAHOMA CITY, OKLA.
Hart Industrial Supply Co.
TULSA, OKLA.
Hart Industrial Supply Co.
NEW ORLEANS, LA.
Wm. D. Seymour Co.

**MIDDLE WEST**
CHICAGO, ILL.
Machinery & Welder Corp
CINCINNATI, OHIO
Williams & Co., Inc.
CLEVELAND, OHIO
Williams & Co., Inc.
COLUMBUS, OHIO
Williams & Co., Inc.
DETROIT, MICH.
C. E. Philips & Co., Inc.
FORT WAYNE, IND.
Wayne Welding Sup. Co., Inc.
KANSAS CITY, MO.
Welders Supply & Repair Co.
MOLINE, ILL.
Machinery & Welder Corp.
MILWAUKEE, WIS.
Machinery & Welder Corp.
ST. LOUIS, MO.
Machinery & Welder Corp
WICHITA, KANSAS
Watkins, Inc.

**WEST COAST**
FRESNO, CALIF.
Victor Equipment Co.
LOS ANGELES, CALIF.
Victor Equipment Co.
PORTLAND, OREGON
J. E. Haseltine & Co.
SAN DIEGO, CALIF.
Victor Equipment Co.
SAN FRANCISCO, CALIF.
Victor Equipment Co.
SEATTLE, WASH.
J. E. Haseltine & Co.

**CANADA**
MONTREAL, CANADA
G. D. Peters & Co. of Canada, Ltd.

**HAWAII**
HONOLULU, HAWAII
Hawaiian Gas Products, Ltd.



# AN ARCOS WAREHOUSE STOCK IN YOUR CITY...

## *or close at hand...*

★Chrome-Nickel Stainless Electrodes
Straight Chrome Stainless Electrodes
Chrome-Moly Steel Electrodes
Manganese-Moly Steel Electrodes
Non-Ferrous (Bronze, Nickel, etc.) Electrodes

★Available for DC or AC Welding

**ARCOS CORPORATION**
401 NORTH BROAD ST., PHILADELPHIA 8, PA.

ARMY NAVY

**it's ARCOS for stainless electrodes**

"QUALITY WELD METAL EASILY DEPOSITED"

# *WHAT'S NEW*

## IN MANUFACTURERS' LITERATURE

*"Indium and Indium Plating".* Indium Corp. of America. Bulletin 182.

*Special data sheets* on compounds for various cleaning jobs are offered by MacDermid, Inc. Bulletin 436.

*Two informative* cleaning booklets have been issued by Detrex Corporation. 16-page booklet emphasizes fundamental practices for economical use of degreasing solvents in metal cleaning departments. 8-page booklet describes alkali and emulsion cleaning compounds for all types of metal cleaning jobs. Bulletin 554.

### ENGINEERING • APPLICATIONS • PARTS

*"Metal Quality"* is the title of this 40-page booklet showing how the progressive hot working of steel in the rolling mills and with closed dies in forging hammers improves the quality and strength of the metal. Drop Forging Assn. Bulletin 610.

*General booklet* on B. F. Goodrich Co.'s industrial rubber products discusses devices of rubber and metal which reduce vibration, molded, extruded, lathe cut and sponge rubber products, rubber lined tanks and valves and other products. Bulletin 614.

*A complete 168-page* commercial catalog on powder metallurgy has been released by Chrysler Corporation's Amplex Division. It presents a wide variety of up-to-the-minute engineering developments and facts on powder metal bearings and parts. Bulletin 583.

*Heat resisting alloys,* cast-rolled-fabricated, and a line of heat treating equipment, are described and illustrated in this 12-page booklet. Michigan Steel Casting Co. Bulletin 584.

*4-page bulletin* describes and illustrates the various types of Meehanite manufactured for wear resisting applications. Meehanite Research Institute. Bulletin 585.

*Illustrated literature* describes details and advantages of Elastic Stop Nuts. Elastic Stop Nut Corp. Bulletin 595.

*Weldco crates* and baskets that provide extra pay load, longer service life and greater safety are described in literature by the Youngstown Welding and Engineering Co. Bulletin 598.

*Heat treating fixtures* for pit-type furnaces are shown in new booklet by Driver-Harris Co. Bulletin 363.

*Pressed steel pots* are described by Bell & Gossett Co. in new Bulletin 364.

*Specifications and physical properties* of bronze and aluminum alloys are shown in Olds Alloys Co. Bulletin 457.

*24-page catalog* is guide to properties and use of Monsanto plastics. Monsanto Chemical Co. Bulletin 31[illegible]

*Carburizing Boxes.* Pressed Steel Co. Bulletin 193.

*Chace manganese alloy No. 772* in sheets, strips, rod and special shapes described by W. M. Chace Co. Bulletin 190.

*Catalog* gives complete specification data on Bunting bearings and bars. Bunting Brass & Bronze Co. Bulletin 343.

*16-page booklet* gives engineering standards and technical information on "AERO-THREAD" screw thread system. Well-illustrated and helpful booklet by Aircraft Screw Products Co., Inc. Bulletin 567.

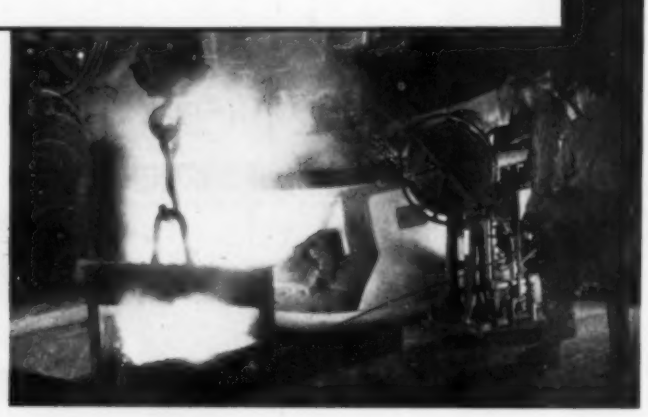
*Illustrated leaflet* presents data and uses of special alloys resisting corrosion, high temperatures and abrasion. The Duraloy Co. Bulletin 390.

*Three-color chart* of decimal equivalents. John Hassall, Inc. Bulletin 458.

*Drop, hammer and upset forgings.* Kropp Forge Co. Bulletin 534.

*Steel Forgings.* Transue and Williams Steel Forging Co. Bulletin 535.


FOR *Faster* MELTING OF HIGH ALLOY STEELS



MOORE RAPID *Lectromelt* FURNACES

Lectromelt furnaces of the top charge type produce steel faster by reducing the charging time. By minimizing the time between heats, more steel tonnage per man hour is obtained. Sizes range from 100 tons to 250 pounds capacity.

PITTSBURGH LECTROMELT FURNACE CORPORATION
PITTSBURGH, PENNSYLVANIA



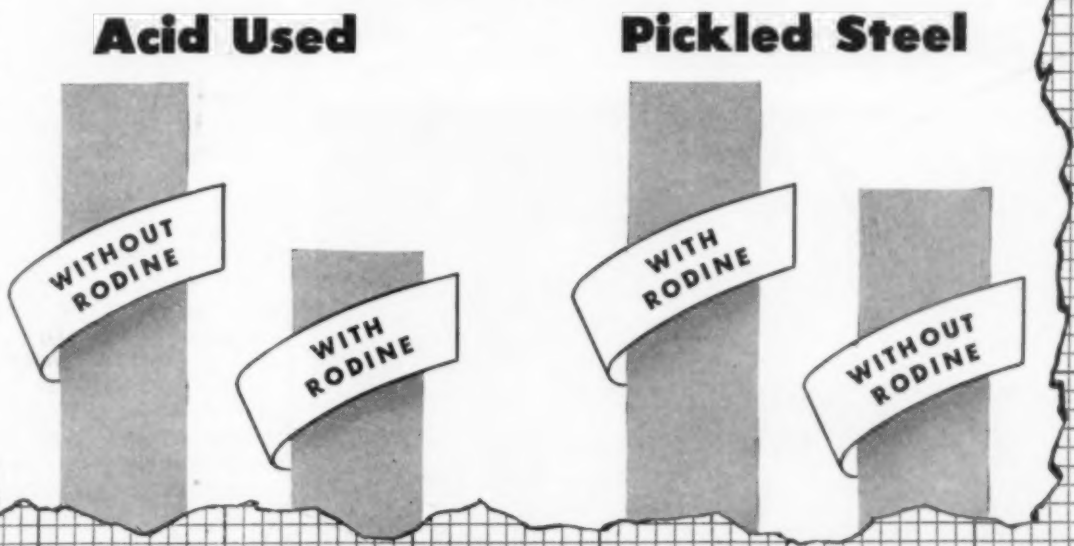
Use Handy Coupon on Page 1120 for Ordering Helpful Literature.

Other Manufacturers' Literature Listed on pages 1120, 1122, 1124, 1126, 1128, 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1147, 1148, 1152, 1154 and 1156.

# Rodine STOPS PICKLING WASTE

## PICKLE BATH COMPARISONS · CASE HISTORY No. 707

PICKLING ONE TON OF STEEL




*Pickling one ton of steel with RODINE in the pickle bath required 50 lbs. less acid and yielded 25 lbs. more pickled steel than one ton pickled without RODINE.*

*Only 1/4 pt. of RODINE was required, to make these savings, at a cost of approximately 6 1/4 cents against a saving in acid of about 25 cents and increase in steel produced of around 50 cents.*

RODINE saved approximately 12 times its cost in acid and metal saved. A further plus value is realized by minimizing rejections due to embrittlement and blistering.

RODINE has revolutionized pickling by confining the action of acid to the removal of scale and rust and inhibiting its action on clean metal. Before Rodine was developed by ACP Chemists there was always an excessive consumption of acid due to its wasteful attack on clean metal. It is now possible to schedule larger production of well-pickled steel and be assured of obtaining it. As the acid attack on clean metal is reduced by Rodine, much less hydrogen gas is liberated with a result that the objectionable acid spray is reduced if not eliminated. Further, with less hydrogen evolved in pickling, less is absorbed into the metal and less embrittlement occurs.

ACP PICKLE BATH TONERS, at times used along with suitable RODINES, at other times alone, improve pickling under abnormal conditions. If, for example, work is oily, the addition of Pickle Bath Toner will improve the pickling. In cool sulphuric acid baths where little inhibition is desired, the addition of Pickle Bath Toner will improve the pickling and pickled surface. The dragout loss in any pickle bath is reduced when the Toner is used.

*Manufacturers of Inhibitors & Metal Working Chemicals*

**AMERICAN CHEMICAL PAINT CO.**
AMBLER ACP PENNA.

*Note: West Coast Plants may address inquiries and orders for prompt delivery to: Leon Finch, Ltd., 728 East 59th St., Los Angeles, Calif.*

**American Chemical Paint Company, Ambler, Pa.**
Please send me general Technical Service Data Sheets on
☐ Rodine ☐ ACP Pickle Bath Toners

*Name*_____ *Title*_____

*Company*_____

*Address*_____

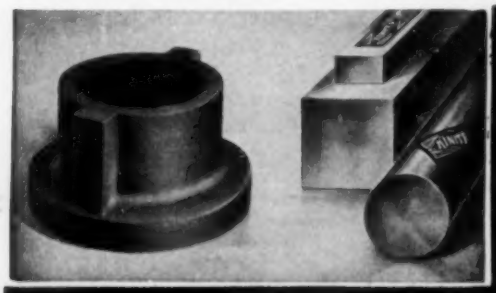
L-11

# *WHAT'S NEW*

## IN MANUFACTURERS' LITERATURE

*Heat and corrosion* resistant castings as engineered by Alloy Casting Company are described along with plant facilities in an interesting 20-page booklet. Bulletin 557.

*"Mechanical Springs,* Their Engineering and Design" is the title of a 106-page handbook just issued jointly by the divisions of Associated Spring Corporation. Bulletin 481.

KINITE

THE STEEL WITHOUT AN EQUAL

KINITE is in the high carbon chrome alloy tool steel air hardening class.

**An analysis all of its own . . . .**
**Its characteristics:**

1. Increases production.
2. Reduces grinding and retooling time.
3. Resists wear and abrasion.
4. Excellent machinability.
5. Minimum distortion.
6. Fine heat treatability.
7. Immune to cracking during heat treatment.
8. In bar stock or castings.

**KINITE alloy air hardening steel offers an unusual combination of features never before found in a steel of this type.**

*Pamphlets on request.*

EST. BOKER 1837

**H. BOKER & CO., Inc.**
101 DUANE ST. ● NEW YORK


*Cr-Ni-Mo Steels.* A. Finkl & Son Co. Bulletin 203.

*Industrial baskets, crates, trays* and fixtures. Rolock, Inc. Bulletin 20

*Handsome 12-page brochure* pictures the cast steel breech rings and their advantages as produced by the Ohio Steel Foundry Co. Bulletin 51

*Many types of heat treating* and pickling baskets and containers are shown in new booklet by the Stanwood Corp. Bulletin 445.

*Specifications and diagrams* are included in description of welded rings and bands. American Welding & Mfg. Co. Bulletin 536.

*Complete line of Mallory* radio electrical and electronic parts, with sizes, dimensions and rated capacities is described in new 36-page booklet. P. R. Mallory & Co., Inc. Bulletin 448.

*New 32-page illustrated* booklet contains much data on manganese steel for the railroad industry. American Manganese Steel Div. Bulletin 388.

*New information sheets* on tapered and formed tubes have just been issued by Summerill Tubing Co. Bulletin 369.

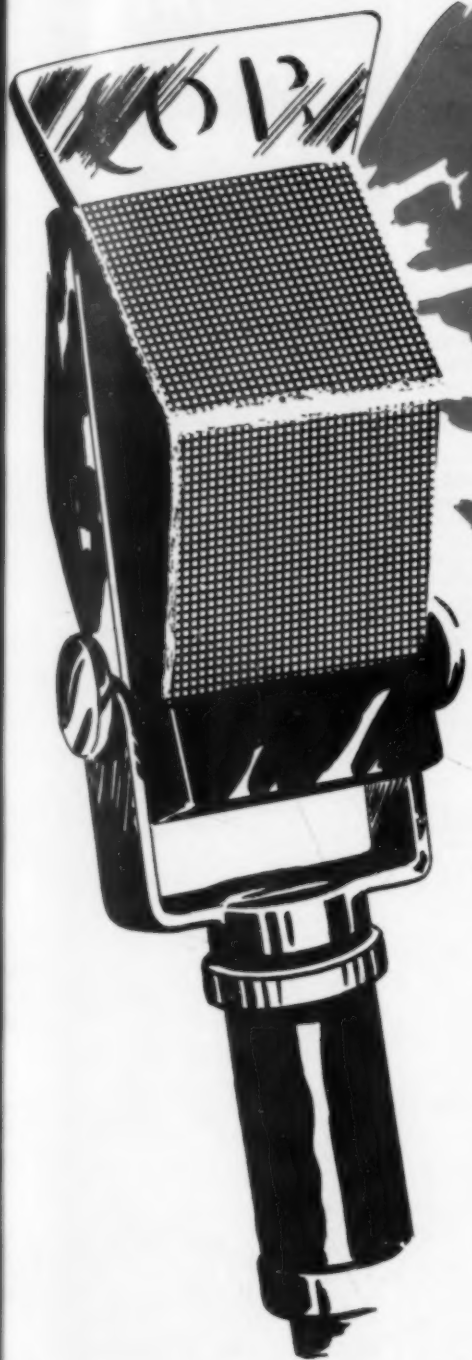
*54-page booklet,* "File 41—Engineering Data Sheets", gives complete facts on Ampco Metal's physical properties and service record. Bulletin 368.

*Electrical,* corrosion and heat resisting alloys in rod, wire, ribbon and strip forms. Wilbur B. Driver Co. Bulletin 192.

*Reference data book* entitled "The Improvement of Metals by Forging" has been issued by Steel Improvement & Forge Co. Bulletin 409.

*Interesting* and informative literature on "Pomet" powder metallurgy products. Powder Metallurgy Corp. Bulletin 454.


Use Handy Coupon on Page 1120 for Ordering Helpful Literature.
Other Manufacturers' Literature Listed on pages 1120, 1122, 1124, 1126, 1128, 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1147, 1148, 1150, 1154 and 1156.



# ...And Now the $64 Question

**Question: "How are Mac Dermid Incorporated metal cleaning compounds different from ordinary metal cleaners?"**

**Answer:** Many years ago when the automotive industry was still young and "cure-all" cleaners still the accepted procedure prior to finishing or plating, MAC DERMID INCORPORATED was founded upon the policy of furnishing a personal service to the few forward thinking manufacturers, chemists and plating and finishing room foremen who realized the increasing importance of specialized cleaning.

Through this type of service many of the now accepted plating and finishing procedures were developed. Methods of cleaning and compounds have been introduced that have made possible fast-positive cleaning of all types of metals under varying conditions, with all types of equipment for advanced finishing and plating techniques.

METEX compounds, developed by MAC DERMID INC., have been made available in many special variations for practically every known cleaning problem. The ANODEX Reverse Current PROCESS which was originally introduced by MAC DERMID INC., is now the accepted electro-cleaning procedure. Special ANODEX compounds may now be had for every cleaning problem.

In addition to METEX and ANODEX compounds MAC DERMID INC. chemists have perfected new variations of special formulations for stripping and spray and tumbling barrel cleaning operations. Write for free Data Sheets or folders on the compounds and equipment best suited to your need.

*Compounds and Equipment for Metal Finishing*

# MAC DERMID

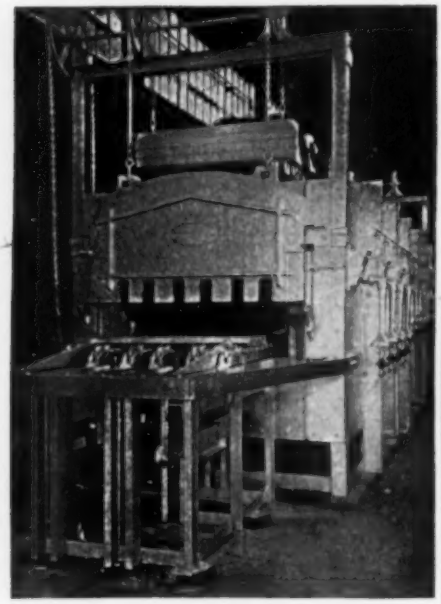
## INCORPORATED

## WATERBURY 88, CONNECTICUT

WRITE ONE OF THESE SERVICE ORGANIZATIONS FOR FREE DEMONSTRATION

| NEW YORK | DETROIT | CHICAGO | CLEVELAND | ST. LOUIS | TORONTO—CAN. |
|---|---|---|---|---|---|
| Udylite Corp. (L. I. City) | Udylite Corp. Wagner Bros. | Udylite Corp. Geo. A. Stutz Mfg. Co. | Udylite Corp. McGean Chem. Co. | LaSalco, Incorporated | Clark Industrial Supplies Co. |

# BELLEVUE
## Job-Designed
# FURNACES



● In the construction of Bellevue Furnaces, painstaking consideration of the job to be done comes first. Every factor must be evaluated, every condition studied. Only then do Bellevue engineers attempt design and recommendation of furnace type.

The soundness of that policy is being demonstrated in plant after plant. Hundreds of executives in scores of varied companies have proved, to their own satisfaction, the efficiency, speed, high production level and operating economies of Bellevues that were "designed" for the job.

You, too, will find Bellevue experience and facilities a profitable investment for your own furnace needs.

Send for full details.

BELLEVUE INDUSTRIAL FURNACE CO.

2980 Bellevue Ave Detroit, Mich.


## *WHAT'S NEW*

IN MANUFACTURERS' LITERATURE

*X-Ray Inspected Castings.* Electro Alloys Co. Bulletin 197.

*Steel Castings.* Chicago Steel Foundry Co. Bulletin 199.

*Heat Resisting Alloys.* General Alloys Co. Bulletin 200.

*The Wilco Blue Book* deals with the 29 Wilco Thermometals, their properties, functions, applications and temperature ranges. H. A. Wilson Co. Bulletin 531.

*Illustrated leaflet* describes stainless steel castings by Atlas Foundry Co. Bulletin 437.

*Illustrating* several heat resistant alloy applications, this 4-page leaflet cites four factors essential to efficient alloy use. Sterling Alloys, Inc. Bulletin 504.

*Cooper standard alloys.* Cooper Alloy Foundry Co. Bulletin 206.

### MELTING • CASTING • MILL OPERATIONS

*Melting of soft metals* in Surface Combustion furnaces is described in this illustrated leaflet. Bulletin 606.

*Crucible melting furnaces,* stationary and tilting types, oil or gas fired, are described in this leaflet by W. S. Rockwell Co. Bulletin 609.

*Ingot Production.* Gathmann Engineering Co. Bulletin 185.

*Comprehensive* casting defect chart is presented in the July Foundrymen's News Letter available through Harry W. Dietert Co. Bulletin 573.

*New Tercod Crucible* Catalog tells how to achieve faster melting, lower costs per casting, conserve fuel and solve many other important, current problems. Electro Refractories and Alloys Corp. Bulletin 574.

*Electric Furnaces.* Detroit Electric Furnace Div., Kuhlman Electric Co. Bulletin 189.


Use Handy Coupon on Page 1120 for Ordering Helpful Literature.
Other Manufacturers' Literature Listed on pages 1120, 1122, 1124, 1126, 1128, 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1147, 1148, 1150, 1152 and 1156.



THE PENINSULAR STEEL CO.

CHERRY 7173

2222 Lakeside Ave.

CLEVELAND

Emergency Phone LAkewood 1133

WAREHOUSES

Akron
915 Miami St.

Chicago
122 S. Damen Ave.

Dayton
401 Kiser Street

Detroit
1040 McDougall Ave.

Grand Rapids
1590 Madison Ave., S.E.

Toledo
25 Sylvania Ave.

REPRESENTATIVES

Erie
C. E. Wolff Jr., 3816 Sassafras St.

Rockford, Ill.
Rockford Industrial Supply Co.

## BUTT WELDED MECHANICAL TUBING

*Hot Rolled and Cold Drawn to*
**Standard Tubing Tolerances**

*Range of Sizes*
Cold Drawn ½" O. D. to 2⅜"
Hot Rolled .670" O. D. to 4" O. D.

Ordnance and Industrial Applications
U. S. A. Specifications 57-180
Type IV W. D. 1010-1015

**PITTSBURGH TUBE COMPANY**
323 Fourth Ave., Pittsburgh, Pa.

*Representatives*

| | | |
|---|---|---|
| Service Steel Co., | 1435 Franklin St., | Detroit, Mich. |
| Service Steel Co., | 765 Hertel St., | Buffalo, N. Y. |
| Service Steel Co., | 1249 W. Fulton St., | Chicago, Ill. |
| Service Steel Co., | 2442 Hunter St. | Los Angeles, Cal. |
| Service Steel Co., | 1074 Summer St., | Cincinnati, O. |

Standard Tube Sales Corp., One Admiral Ave., Maspeth, N. Y.

# Columbia TOOL STEEL

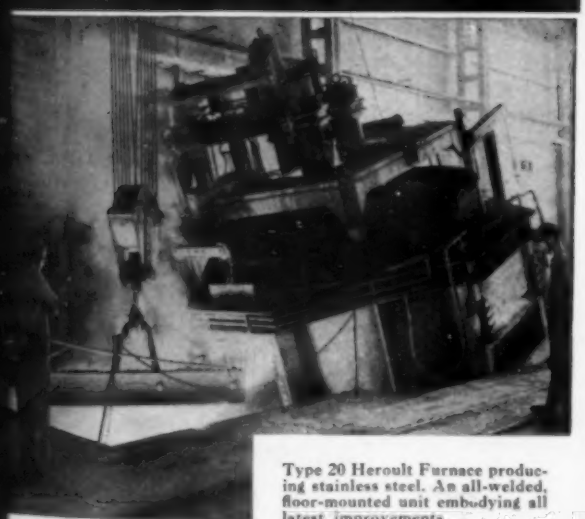
**V-E DAY—**

With V-E Day this good tool steel that made war time records will be ready for the new jobs and for doing old jobs better.

*It pays to use Good Tool Steel.*

**COLUMBIA TOOL STEEL COMPANY**
ARTHUR T. CLARAGE, PRESIDENT
MAIN OFFICE AND WORKS
500 EAST 14TH STREET • CHICAGO HEIGHTS, ILL.

## Heroult ELECTRIC FURNACES



Type 20 Heroult Furnace producing stainless steel. An all-welded, floor-mounted unit embodying all latest improvements.

PARTICULARLY designed and equipped for high-quality melting and refining of ferrous materials by either basic or acid process—including alloy, tool and forging steels, iron and steel castings. Any capacity from ½ ton to 100 tons; removable roof, chute, machine or hand charging.

**AMERICAN BRIDGE COMPANY**
*General Offices: Pittsburgh, Pa.*
*Offices in the larger cities*

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
United States Steel Export Company, New York

**UNITED STATES STEEL**

# DILLON

## PRECISION DYNAMOMETER

**INDICATE TENSION DIRECT IN POUNDS!**

9 capacities from 0-500 lbs. up to 0-20,000 lbs.

Weigh only 8 lbs. 4 oz., measure 8¼" x 6¼" x 3"

An ideal laboratory or field instrument for indicating tension or stress in cable, rope, castings, assemblies, many other mechanical setups. Thousands in use by leading plants. Fits into "tight" spots easily. Not injured by accidental overload. Has safety glass cover and maximum hand. PRICED LOW. Immediate shipment.

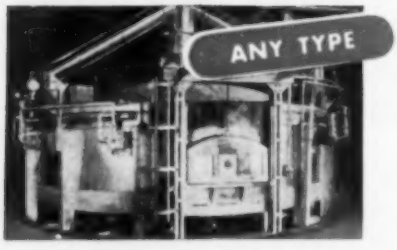
*WRITE FOR INTERESTING BULLETINS*

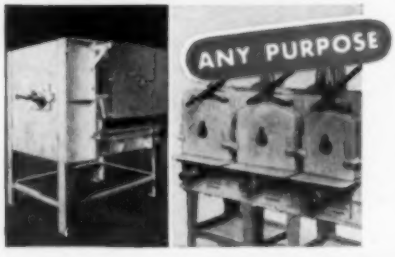
**W. C. DILLON & CO., Inc.** 5420 WEST HARRISON ST. CHICAGO 44, ILL., U.S.A.

# Heat treating "Know how"

"Working-it-out" conferences between metallurgist, combustion engineer and furnace designer insure the best, most practical solution to your heat-treating problems.

*. . . to put your post-war product on a profit basis*




DON'T let out-moded, inefficient and costly heat-treating procedures handicap you when the day arrives to resume peacetime operations.

War's needs have accelerated the development of improved heat-treating techniques designed to get out of steel *all* of the predetermined properties put into it by the steel maker.

Properly applied, *modern* heat-treating—as typified by Austempering, Martempering and Purnellizing—insures improved and more uniform physical properties. Increases machinability. Reduces warpage. Provides freedom from soft spots and cracking. It minimizes re-treating and rejections. The result—a better product at lower cost!

Here at Tate-Jones we offer you thorough and practical knowledge of these advanced heat-treating methods—as well as of conventional heat-treating practice.

We can furnish not only expert metallurgical and engineering advice to improve your heat-treating but can provide the proper equipment to exactly fit your needs:—oil and gas-fired furnaces of all types, either standard or custom-built—salt and lead pots—oil tempering tanks of the latest type—all engineered to operate at maximum efficiency and to give you the results desired.

46 years experience building quality industrial furnaces and heat-treating equipment is behind this service.

FURNACE ENGINEERS

# TATE-JONES

& CO. INC. · LEETSDALE (Pittsburgh District) PA.

Rotating Hearth, Car Bottom, Pusher, Conveyor, Roll Down, Horizontal and Vertical Pit, Circular and Rectangular Pot Furnaces. Also Gas, Oil and Combination Burners


## *WHAT'S NEW*

**IN MANUFACTURERS' LITERATU**

*8-page illustrated booklet* descri crucible melting furnaces for br bronze, aluminum, copper and o alloys. Stroman Furnace & E neering Co. Bulletin 473.

*This ring-binder* presents 24 p on the use and effect of Titaniu steel and cast irons. Titanium A Mfg. Co. Bulletin 470.

*52-page booklet* describes M rapid Lectromelt furnaces for i steel, nickel and copper melting refining. Pittsburgh Lectromelt F nace Corp. Bulletin 404.

*"Electromet Products and Servi* Electro Metallurgical Co. Bull 186.

*Interesting and helpful* infor tion available on the use of a pots for heating operation by Swedish Crucible Steel Co. Bull 137.

*Operating Features,* capaci charging methods of the He electric furnace. American Br Co. Bulletin 215.

*"Fisher Magnesium Scrapbo* Fisher Furnace Co. Bulletin 281.

*Attractive booklet* descri growth, facilities and offers valu alloy hints. Niagara Falls Smel & Refining Corp. Bulletin 246.

*Interesting, descriptive leaflet* metal reclaiming mill offered Dreisbach Engineering Corp. B tin 284.

*4-page leaflet describes* an proved line of Despatch Oven C Coremaster Drawer Type Ov Advantages of this type of oven the large and small foundry list of 48 standard models avail are presented. Bulletin 556.

### GENERAL

*New leaflet* describes inter communication system offered Executone Communication Syst Bulletin 385.


Use Handy Coupon on Page 1120 for Ordering Helpful Literature.

Other Manufacturers' Literature Li on pages 1120, 1122, 1124, 1126, 1128, 1132, 1134, 1136, 1138, 1140, 1142, 1146, 1147, 1148, 1150, 1152 and 115